

QUEEN OF THE STONE AGE
Stunning burial reveals Europe's deep past

NewScientist

WEEKLY March 21 - 27, 2015

THE MIRROR OF OUR SELVES

To understand people, we're going to have to build one



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JIM WILSON/EVINE

One size fits all?

Tackling the big challenges in public healthcare takes unity

IN A few weeks' time, you'll be able to buy a watch that might extend your life. Enthusiasts of wearable health technology hailed Apple's announcement of a timepiece that measures the wearer's heart rate, an app that monitors their activity, and a software kit that can gather data from millions of iPhone users.

So far, the hope that wearables can transform our health has been just that: hope, or less generously, hype. But if any company or organisation has the clout to change that, it is Apple. Such technology could have huge benefits, but it also raises huge questions. Some worry that it will turn us into obsessively self-monitoring hypochondriacs. It is not hard to see how shoddy apps could offer confusing or bad advice. And there is little precedent to tell us how public health services might work with such private platforms – or how they might be supplanted by them.

Technology is only one of the trends reshaping public health: increasing longevity, climate change, antibiotic resistance and inequality will all have far-reaching consequences, as we report this week (see page 22). The challenges they pose go far beyond political wrangling over the funding of healthcare.

The UK's National Health Service is a case in point: it says it will need to spend £30 billion more each year by 2020-21 than it receives at present just to stand still. Efficiency savings and new ways of working might free up some of this cash, but an extra £8 billion a year would still be needed over the term of the next parliament. And those figures don't include some of the challenges ahead. For example, *New Scientist* understands that

"The fact that the public purse is far from full is all the more reason to prepare for these threats now"

the UK's Review on Antimicrobial Resistance will not tot up costs to the healthcare system when it reports in May.

The fact that the public purse is far from full is all the more reason to prepare for these trends now, even if their full force won't be felt within the next electoral cycle. That is better recognised in some areas than others. The challenges posed by increasing longevity are widely accepted, as is the need for responses such as the integration of health and social care. The NHS is already engaged in efforts to prepare for the effects of climate change. It bodes well that the

biggest UK parties have all agreed to observe the country's commitments to mitigate climate change; a similar consensus on healthcare would be welcome.

The response to antibiotic resistance must also be driven by science, not ideology. So far, this issue has been ably championed by the UK chief medical officer, but it will be up to the politicians to mandate action. If the reaction is tempered by the kind of innumerate scoffing we have seen from some about the need for pandemic flu preparations, it will prove fatal for millions. So far, though, the signs seem good.

That's not the case when it comes to the well-proven but ideologically charged link between economic inequality and health disparities, which no political party seems to want to tackle seriously – and which the other trends may exacerbate.

The most expensive model of Apple's watch will cost a cool \$10,000. For the moment, it offers the same functionality as cheaper variants. But one day the proud owner of a high-end wearable may be entitled to gold-plated medical care, as well as timekeeping. Do we want that ever widening disparity? That's a decision for all of us to make – and we must make it soon. ■

Vanuatu calls for action

INEVITABLY, climate change has been blamed for Vanuatu's worst natural disaster in living memory. Cyclone Pam has killed at least 11 people and 15,000 homes are thought to be uninhabitable across the country's 65 islands in the South Pacific. Winds reached almost 300 kilometres per hour, and a hospital and medical repository have both reportedly lost their roofs.

The cyclone hit while Vanuatu's president, Baldwin Lonsdale, was in Japan with other world leaders for the UN's third World Conference on Disaster Risk Reduction. Speaking in Japan, Lonsdale linked cyclone Pam - and other recent cyclones - to climate change.

Lonsdale said that in the past, the country was rarely hit by cyclones in

March, but that it has become a regular occurrence for the last three years. World Bank Group vice-president and special envoy for climate change, Rachel Kyte, agrees with Lonsdale. She says the four tropical cyclones currently threatening islands in the Indian and Pacific Oceans are very unusual.

"One of the reasons for this trend is a vastly warmer Pacific Ocean," she says. "We know that we are embarking on an incredibly volatile decade, in large part because of climate change. So the number of people in the world who will be increasingly in harm's way from an intensity and frequency of disasters, from floods to droughts to storms, means that this should be urgent. It is urgent that we change the way we do development."



Cyclone patterns are shifting

Don't alter embryos

WHOA, whoa. Let's put the brakes on and talk some more. This is the message from scientists who are concerned that their colleagues are rushing head-first into replacing faulty genes in early human embryos, sperm and egg cells without considering the consequences. Such changes affect DNA in the nucleus and so would be heritable - ultimately, they could be used to create a genetically modified baby.

Writing in the journal *Nature*, scientists from advocacy group

We don't know the details yet, but based on what's been done in monkeys, the work probably involved fertilising human eggs by injecting a sperm cell and then various RNAs. These RNAs cut DNA at specific sites, tricking our natural DNA repair system into destroying or replacing one or more genes. The embryos would then have been allowed to develop for a few days before being destroyed. Sequencing the embryos' DNA would have shown if the gene editing had worked.

The ARM scientists argue that editing genes in the germline is dangerous, unnecessary and could lead to designer babies. They also claim it could trigger a backlash that would impede editing genes to produce non-heritable changes in our bodies, something that the authors are pursuing in their own research. A wide range of diseases, from HIV to cancer, could potentially be treated this way (*Nature*, doi.org/2v3).

"At this early stage, scientists should agree not to modify the DNA of human reproductive cells," they write.

the Alliance of Regenerative Medicine (ARM), have called for a moratorium on such gene editing. The move was triggered by reports that several groups have tried modifying the genome of a human embryo and submitted their results for publication. This kind of research is already illegal in some countries.

"At this early stage, scientists should agree not to modify the DNA of human reproductive cells"

Penis transplant

NINE more men could soon receive new penises following news last week of the world's first successful penis transplant.

Performed in December, the 9-hour procedure relied on surgical techniques developed for face transplants to connect fine blood vessels and nerves to the new organ.

Although full sensation is expected to take two years to return, the 21-year-old recipient can already achieve erections

and orgasms and can ejaculate and urinate. "Our goal was that he would be fully functional at two years, and we are very surprised by his rapid recovery," says André van der Merwe of Stellenbosch University in South Africa, who carried out the surgery.

The team had been planning the procedure since 2010 and now hopes to repeat it. Like an estimated 250 South African men each year, the recipient had to have his original penis amputated following a botched traditional circumcision when he was 18.

Comet mysteries

#ROSETTAWATCH

COMET 67P is giving up its secrets. Philae, the probe that landed on its surface in November, has provided a wealth of data. But researchers are desperate for the probe to wake up again, because they have been left with as many questions as answers.

The latest pictures from Philae, taken during its descent, were released on Monday at the Lunar and Planetary Science Conference in The Woodlands, Texas. They suggest

that what looked like the kind of wind-blown dunes you see on Earth might really be created by jets of gas moving dust on the comet's surface.

Other pictures, taken after Philae landed, show the comet's surface is partly made up of tiny pebbles.

The spacecraft is unlikely to be warm enough to wake up until May, when the seasons change on 67P and its dark side is illuminated - Philae is thought to be just on the wrong side of the dividing line.



Contraband food

IS THAT steak legal? They may not realise it, but Europeans are eating produce grown by farmers who have illegally cleared forests in tropical countries, according to a report this week by European NGO FERN.

JUSTIN SULLIVAN/GETTY



Shrinking inexorably

“The European Union is the biggest importer of illegal agricultural produce. We should be more discerning”

The report is the first to quantify just how much of this deforestation is unlawful. It links specific illegally produced products to the countries that import them: beef with the UK, soy with France, leather with Italy. The EU imports 25 per cent of soy, 18 per cent of palm oil, 31 per cent of leather and 15 per cent of beef produced illegally, it says.

“The European Union is the biggest importer of these illegal products,” says Sam Lawson, the report’s author. “We’re not saying these commodities should not be imported, we’re saying that Europe should be more discerning.”

European governments should outlaw the illicit clearance of forests for agriculture, says Lawson. An EU ban on illegal timber imports has helped stamp out unlicensed logging, but agricultural commodities are a much bigger driver of deforestation, he says.



More questions than ever

ESA/ROSETTA/NAVCAM

California’s thirst

THE largest state in the US is bone dry, and time is running out to save it. Jay Famiglietti, a hydrologist at NASA’s Jet Propulsion Lab and the University of California, Irvine, put out a stark warning last week: start rationing water now to avoid disaster.

Writing in the *Los Angeles Times*, Famiglietti warned that the state is down to its last year of above-ground reserves, and that its groundwater backup is rapidly

“California has no contingency plan for a persistent drought except praying for rain”

disappearing. “California has no contingency plan for a persistent drought like this one,” he wrote, “except, apparently, staying in emergency mode and praying for rain.” Groundwater is now a primary source of water, as the state experiences its fourth year of severe drought.

California has pumped 15 cubic kilometres out of its main aquifers every year since 2011, according to NASA satellite data. In some places, the ground is sinking at a rate of 30 centimetres a year as a result. No one even knows how the groundwater is being used, as the state has no policies to keep track of it.

Famiglietti also called for the speedier implementation of California’s Sustainable Groundwater Management Act, the first law empowering local agencies to regulate and keep account of groundwater extraction. The act requires full sustainability by 2042. “By then, there may be no groundwater left to sustain,” he wrote.

Mars blues

ARE we ever going to get to the Red Planet? If Mars One has its way, people will be living there by the mid-2020s. But the Dutch firm behind the much-hyped plan came under fire this week from a candidate who has been shortlisted for the one-way trip.

Joseph Roche, a physicist at Trinity College Dublin in Ireland, says there are serious problems with the mission, alleging that applicants progress based on how many points they accumulate during the process, and that points could be gained by donating money to Mars One or buying merchandise from the firm. High-profile candidates were simply those who had donated the most, he claimed.

However, Suzanne Flinkenflögel of Mars One says candidates’ donations do not have any influence on the astronaut selection process.

60 SECONDS

Dino whiskers

Dinosaurs’ feathers probably first functioned like facial whiskers, keeping dirt out of eyes and acting as tactile sensors to help the owner get around. After that, they could have developed into warm coats (*Evolution*, doi.org/2vz).

Gulls tanked on mercury

No wonder numbers of the Arctic-dwelling ivory gulls have plunged by 80 per cent since the 1980s. Analysis of museum specimens from Canada and Greenland dating from 1877 to 2007 shows that the amount of mercury in their feathers has increased 45-fold in that period. Human pollution may be to blame (*Proceedings of the Royal Society B*, DOI: 10.1098/rspb.2015.0032).

Digital Mosul

Objects destroyed in ISIS’s recent attack on Mosul Museum, Iraq, could be resurrected digitally. Volunteers with Project Mosul will crowdsource photos, images and data about the artefacts and recreate them as 3D models. These could help restore the original object or 3D print a replica.

Cryptic burial

The lost tomb of Spanish writer, Miguel de Cervantes, has been uncovered. The author of *Don Quixote* was buried in 1616 in Madrid’s Convent of the Barefoot Trinitarians, but his remains were lost when the church was rebuilt. Infrared cameras, 3D scanners and radar were deployed to identify the burial site, in a crypt beneath the convent.

Bright lights, early bird

City lights change blackbirds’ perception of time. Birds living in Munich, Germany, reached sexual maturity 19 days ahead of their rural cousins. The city slickers felt the day was around 49 minutes longer, corresponding to a 19-day shift in season because of the artificial city lighting (*Philosophical Transactions of the Royal Society B*, doi.org/2v2).

Unveiling the Red Lady of El Mirón

A unique fossil is revealing Stone Age secrets, says **Penny Sarchet**

SHE was privileged to have a tombstone, and her grave may have been adorned with flowers. But the many who, for millennia after her death, took shelter in El Mirón cave in northern Spain must have been unaware of the prestigious company they were keeping. Buried in a side chamber at the back of the cave is a very special Palaeolithic woman indeed.

Aged between 35 and 40 when she died, she was laid to rest alongside a large engraved stone, her body seemingly daubed in sparkling red pigment. Small, yellow flowers may even have adorned her grave 18,700 years ago – a time when cave burials, let alone one so elaborate, appear to have been very rare. It was a momentous honour, and no one knows why she was given it.

“She’s not hidden away. In death, she was kind of presiding over the activities of her people”

“It’s an area in the cave right where people were living,” says Lawrence Guy Straus at the University of New Mexico in Albuquerque. Along with Manuel González Morales of the University of Cantabria, Straus has been leading the excavation of El Mirón for 19 years. “It’s not hidden away. This person in death was kind of presiding over the activities of her people.”

The Red Lady, as researchers are calling her, was a member of the Magdalenian people of the late Upper Palaeolithic. They would have been anatomically just like us, they had clothes and probably language, too, and belonged to social networks that spread across Europe. But although they lived in large numbers in Portugal and

Spain, and archaeologists have been searching for burial sites for nearly 150 years, the Red Lady’s grave is the first Magdalenian burial found in the Iberian peninsula (*Journal of Archaeological Science*, doi.org/2t8).

“The Magdalenian age saw a real explosion in the number and abundance of art, and in the realism of the animals represented,” says Straus, especially in sites in northern Spain and France. The El Mirón

cave has its share, including an engraving of a horse and possibly one of a bison too. But most intriguing are the lines scratched upon the 2-metre-wide block of limestone behind which the Red Lady was buried. What looks like a mess of fine, straight lines could actually be far more significant.

“The lines seem to be sort of random, but there is a motif that is a triangle – repeated lines that make a V-shape,” says Straus. “What is being represented, at least by some of these lines, might

be a female person. Conceivably, this block serves as some kind of marker.” It’s as if the Red Lady had a primitive tombstone stating she was female (*Journal of Archaeological Science*, doi.org/2t9).

Her remains were discovered when Straus’s team began digging behind this block in 2010. Radiocarbon dating reveals that the block fell from the ceiling at most only a few hundred years before the woman was buried in the narrow space behind it. “The



LAWRENCE GUY STRAUS

A home and a grave

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block was engraved more or less contemporaneously with the burial,” says Straus.

Dozens of researchers have been excavating El Mirón since 1996, with around 20 working on the Red Lady’s grave since it was found. When they began digging, they discovered the jawbone (see picture, below right) and shin bone (tibia) almost immediately. Both were bright red – although they have since faded – a sign that the woman had been covered in red ochre, a specially prepared iron oxide pigment that humans appear to have slathered on their dead for thousands of years. “It goes back to pre-*Homo sapiens*,” says Straus. “This is a colour that in their lives must have been very spectacular,” he says, suggesting that its blood-like hue may have symbolised life and death.

The people who buried her used a special form of ochre, not from local sources, that sparkled with specular haematite, a form of iron oxide. It may have been applied to her corpse or clothes as a preservative or as a ritual. The regular use of red ochre at burials throughout the Upper Palaeolithic elsewhere in Europe implies this formed part of a burial rite, says William Davies of the University of Southampton, UK. “It is certainly possible that [these people] held spiritual beliefs,” Davies says.

Chewed by canines

But the skeleton is incomplete, a fact that may be linked to gnaw-marks on the tibia left behind. The pattern of black manganese oxide, which forms on bones as bodies rot, shows that a carnivore – about the size of a dog or wolf – took to the tibia some time after the flesh had decomposed.

After this incident, a number of large bones, including the cranium, seem to have been removed, perhaps for display or reburial elsewhere. Many of the remaining bones, including the tibia and jawbone, were treated

once again with red ochre, possibly to resanctify them (*Journal of Archaeological Science*, doi.org/2vzb).

María-José Iriarte-Chiapusso and Alvaro Arrizabalaga at the University of the Basque Country in Spain have taken a different tack, focusing on the pollen found at the burial site. They found an

“This person was given some kind of special treatment. God only knows why”

unexpected preponderance of pollen from the Chenopod group, which includes plants like spinach (*Journal of Archaeological Science*, doi.org/2vc). Chenopod pollen is rare at archaeological sites from this period, and the high concentration found by the researchers doesn’t match the patterns at burial sites in areas where these plants were a food source, says Iriarte-Chiapusso.

It is possible that the plants were used medicinally at this time, but that would still fail to explain the high levels of pollen. “The extraordinary nature of the finds within the burial suggest that [the plants] had been deliberately sought out for some purpose related to the deceased,” says Arrizabalaga. This leads the team to believe that the woman’s people may have left a floral offering at the grave, probably of small, yellowish flowers.

THE PALEO DIET, FOR REAL

Do you want to keep on-trend with the latest fashionable diet? Then look to the Red Lady of El Mirón, who ate the Paleo diet almost 19,000 years ago.

For her, it was no fad. The isotopes in her dental enamel, microscopic wear patterns on her teeth and the stuff embedded between them reveal that the meat of hoofed animals made up about 80 per cent of her diet. That means you might want to add red deer and ibex to your shopping list. Pick up plenty of salmon, too – fish seems to have made up most of the rest of her diet.

If that sounds a little dull, fear not. Meticulous dental analysis reveals she also ate some starchy plant material, most likely to have been

seeds, plus mushrooms, although probably in small amounts (*Journal of Archaeological Science*, doi.org/2t7). Whether fungi were eaten for nutrition or for some other purpose is unknown, says Lawrence Guy Straus of the University of New Mexico.

Could the diet revealed by this unique fossil from northern Spain make you live a longer, healthier life? Although the surviving bones of the Red Lady suggest she was healthy, her age at death was between 35 and 40. That may have counted as middle-aged for people who lived in Palaeolithic times, says William Davies of the University of Southampton, UK.

Perhaps you’d better stick to a balanced diet with five portions of fruit and vegetables a day.

“You can’t get away from the conclusion that this person, [out of] the hundreds and perhaps thousands of Magdalenians who once existed for several thousand years in Iberia, was given some kind of special treatment,” says Straus. “God only knows why.”

Could she have been some sort of leader or queen? “We don’t really know much about the social structure of these hunter-gatherers, whether they were matriarchal or patriarchal societies,” says Ignacio de la Torre of University College London. “But certainly hunter-gatherer societies had no queens or kings,”

he says, as they did not have much of a social hierarchy.

The people who buried the woman may have had some strong emotional connection with her, suggests Davies, or perhaps she was exceptional in some way. “For example,” he says, “some individuals buried in Italy have skeletal abnormalities and might have been seen as a special people, thus warranting a separate burial.”

Whoever she was, the Red Lady lived at a time when Europeans were recovering from the worst of the last ice age, about 21,000 years ago. Many people took refuge in Iberia and southern France, and then expanded back out across the continent. Straus hopes that the Red Lady’s DNA – to be analysed by Svante Pääbo of the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany – will provide evidence that it was these Magdalenians in south-western Europe who went on to repopulate northern areas, including Belgium, Germany and the UK.

Perhaps the DNA will reveal that many Europeans today can trace their ancestry back to her artistic kinsfolk. ■



Most of her own teeth, too

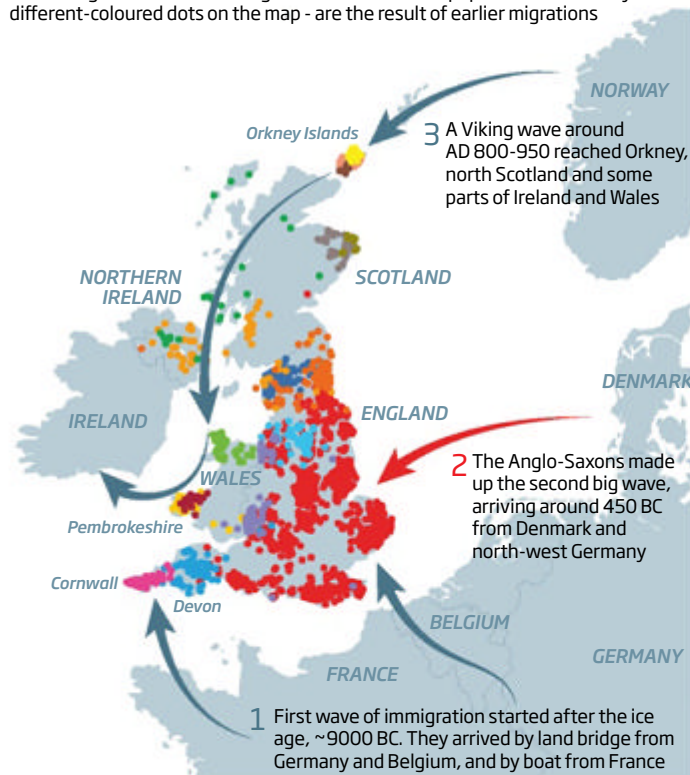
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Anglo-Saxons still dominate England

Britain's ancient roots

The Romans, Vikings and Normans all invaded Britain, but left surprisingly little genetic trace. The influence of the **Anglo-Saxons**, however, shows up across England. Other distinct genetic clusters in the population - shown by different-coloured dots on the map - are the result of earlier migrations



Roman invasion left no genetic legacy

Andy Coghlan

THEY came, they saw, they conquered. But while the Romans, Vikings and Normans ruled Britain for many years, none left their genetic calling cards behind in the DNA of today's mainland Caucasian population. That's the message from the most comprehensive analysis yet of the genetic make-up of the white British population.

The only invaders that left a lasting legacy are the Anglo-Saxons. As well as giving us the English language, the Anglo-Saxons, whose influx began around AD 450, account for 10 to 40 per cent of the DNA in half of modern-day Britons.

The analysis also springs some surprises. There was no single Celtic population outside the Anglo-Saxon dominated areas, but instead a large number of genetically distinct populations (see map, left). The DNA signatures of people in the neighbouring counties of Devon and Cornwall are more different than between northern England and Scotland. And there are also

"History is written by the winners. Genetics, by contrast, is the history of the masses"

unexpectedly stark differences between inhabitants in the north and south of the Welsh county of Pembrokeshire.

The only appreciable genetic input from the Vikings is in the Orkney Islands, which were part of Norway for 600 years. Viking DNA accounts for 25 per cent of today's Orcadian DNA.

The insights come from a study of DNA samples donated by 2039 Caucasian people from around

the UK. Each was selected because all four of their grandparents were born within 80 kilometres of each other, allowing the researchers to infer their grandparents' DNA and later link it to a location. Because the grandparents were born on average in 1885, the analysis enabled a genetic snapshot of Caucasian Britain prior to immigrations since then. "Any one person's genome is a random sample of DNA from all four of their grandparents, so it's a way to look back in time," says Peter Donnelly of the Wellcome Trust Centre for Human Genetics in Oxford, UK.

To identify differences between people who have similar genetic make-ups, Donnelly's team searched not just for single genetic alterations, but how common combinations of those alterations were inherited in large chunks of chromosomes. "That's much richer than looking at each genetic difference individually," says Donnelly.

The team found that the genetic profiles of the participants formed 17 distinct clusters. When they mapped this information based on where the participants lived they were surprised to see the clusters mapped almost exactly to geographical location.

The largest cluster accounted for half the participants and occupies almost the whole of eastern and southern England and most of the Midlands. This turned out to be the genetic legacy of the Anglo-Saxon invasions. Even so, at least 60 per cent of the DNA in the cluster had survived from earlier migrants (*Nature*, DOI: 10.1038/nature14230).

In fact, all 17 clusters are dominated by DNA from settlers that arrived prior to the Anglo-Saxons. By comparing the clusters

with genomes from modern-day continental Europe, the team was able to piece together the general migration pattern that took place.

The first wave of arrivals crossed by land bridges, when sea levels were so low that Britain was attached to what is now northern

IMMIGRATION BRITAIN

What have the Romans done for us?

Before the Romans came, Britain was a highly Balkanised cluster of culturally and genetically isolated tribal enclaves. Starting in AD 43, the Romans dissolved many of these barriers in what is now southern and eastern England – partly through building roads. That same area was subsequently occupied by the Anglo-Saxons from AD 450 onwards. Only in the west and north of Britain did the tribes manage to hold on to their isolation, including genetic isolation from the Anglo-Saxons.

of the Roman, Viking and Norman invasions, it's surprising they didn't leave greater genetic legacy. For the Romans and Normans, that may be because they were ruling elites who didn't intermarry with the natives.

Are some regions of Britain inbred?

No. Although some groups are more genetically distinct, they are only subtly so, with a huge amount of commonality across all British Caucasians. It is easier for differences to accumulate and linger in smaller populations, says Donnelly, whereas they become diluted in larger groups.

Are there any medical implications of the findings?

Identification of regional genetic differences means that any harmless regional variants can be ruled out of

screenings for disease-related genes. "It makes it easier to distinguish these genetic red herrings," says Donnelly.

Could you do a global version of this genetic study?

Studies on larger populations may be easier as people would be more dissimilar from each other genetically than in a small country like the UK. But the team says it would be really interesting to study individual countries, and a similar study is already in progress in Spain.

"The only genetic input the Vikings had in the UK is in Orkney, where 25 per cent of DNA is Viking"

Germany. This wave was dominated by people with genomes most similar to modern-day inhabitants of northern Germany and Belgium. In parallel, migrants from the west coast of France were arriving by boat. Traces of the combined DNA from all these three pioneer settlers forms the basis for the genetic make up of all white Britons.

Given the cultural significance

The overall message is that despite their large cultural impact, Britain's main invaders left no genetic stamp of note. "When you study the past through history, linguistics or archaeology, you learn

about successful people," says Donnelly. "History is written by the winners, so much of current historical information is from a relatively small subset of people. Genetics, by contrast, is the history of the masses." ■

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The hunt is on for habitable moons

Jacob Aron

THE galaxy could be stuffed with large moons that orbit alien worlds, according to an analysis of data from NASA's Kepler space telescope. Such moons are thought to be the most likely places to find alien life, so groups are clamouring to find the first.

Astronomers have raked in thousands of exoplanets, but their smaller moons have proved harder to come by. Kepler looks for exoplanets by watching how the light from a star dips as a planet passes in front, known as

"Astronomers have raked in thousands of exoplanets, but smaller moons have proved harder to come by"

a transit. Moons should produce a smaller, secondary dip, but that dip's timing varies because an orbiting moon can transit before, after or at the same time as its parent planet.

A team led by David Kipping at the Harvard-Smithsonian Center for Astrophysics is searching for exomoons by modelling all the positions one could be in and looking for similar light signals

in the Kepler data. But it's such a computationally intensive strategy that they have had to crowdfund their own supercomputer and borrow NASA's to crunch the numbers.

Now Michael Hippke of the Institute for Data Analysis in Neukirchen-Vluyn, Germany, has road-tested a simpler method. While he didn't find any clear exomoon signals, the results suggest an abundance of moons the size of Jupiter's Ganymede, the largest in our solar system.

This technique, called the orbital sampling effect, was dreamed up last year by René Heller of McMaster University in Ontario, Canada, but Hippke is the first to try it with real data. It works by overlaying all of the transit data for an exoplanet and looking for signs of an extra dip on both sides, to catch the moon in as many positions as possible (arxiv.org/abs/1502.05033).

"The downside is this dip could be caused by other reasons," says Hippke, such as sunspots on the star. The upside is its speed: he was able to process 4000 Kepler planets in just a few months on an ordinary computer. For that reason he thinks this method



How many Ganymedes are out there?

is best used to highlight planets that deserve a closer look. The most promising planet he found, Kepler-264 b, has hardly been examined.

"It is much faster than the technique we use," says Kipping, who expects to have crunched through only 300 planets by the end of 2015. He agrees the new method could guide further searches, but thinks it is unlikely

to find an exomoon. "Personally I would not believe a detection solely based on these quick and dirty methods," he says. "We want the first confirmed exomoon to be an extremely solid, clear case."

Hippke also used the method to look at the statistics of exomoons in general. His results suggest that, on average, planets with orbits of between 35 and 80 days host a single moon the size of Ganymede.

This is great news for alien hunters. Kepler has seen plenty of planets in these short orbits, and if they orbit a red dwarf star, their moons would be right in the habitable zone, where water is liquid. The Hubble Space Telescope recently showed that the real Ganymede has a subsurface ocean, and the same technique could one day identify water hidden within exomoons (see "Ganymede's secret subsurface sea", below). "There might be more habitable exomoons out there than planets," says Hippke. ■

GANYMEDE'S SECRET SUBSURFACE SEA

Lights, camera, ocean! Observations by the Hubble Space Telescope have confirmed the presence of a subsurface ocean on Jupiter's moon Ganymede. The method used could help in the hunt for life outside our solar system.

It has long been thought that Ganymede harboured a secret sea, but evidence had been inconclusive. Now Joachim Saur at the University of Cologne, Germany, and his colleagues have used Hubble to investigate by

studying the moon's aurora.

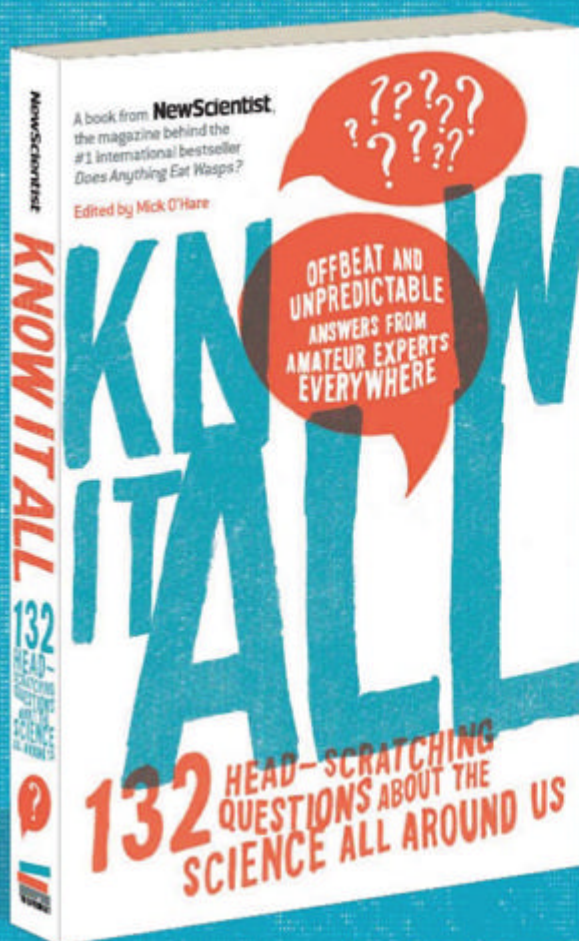
This is produced by Ganymede's magnetic field. But interactions with Jupiter's magnetic field mean the aurora rocks back and forth over a roughly 5 hour period. If Ganymede has a salty subsurface ocean, though, it would reduce this rocking effect. That's because an electrically conductive salty ocean generates its own magnetic field in the presence of an internal magnetic field.

Saur's team watched Ganymede

for 7 hours, and saw this smaller rocking effect. "We cannot explain these observations without an ocean," says Saur (*Journal of Geophysical Research: Space Physics*, doi.org/10.1029/2015JG102555).

The technique could help find subsurface oceans on planets or even moons outside the solar system. Our telescopes are not powerful enough to see these auroras yet, but it is only a matter of time, says Saur. "One day that's going to come."

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IVF nutrients may dictate sex of baby

Jessica Hamzelou

WILL it be a boy or a girl? For people undergoing IVF, the nutrient-rich liquid their embryos grow in could tip the balance. The finding adds to mounting evidence that the culture medium is playing a role in an embryo's development and future health.

Women undergoing IVF are treated with hormones that stimulate the release of eggs. The eggs are collected and fertilised with sperm in a dish. Sperm can either be left to do the job or, if the male partner has fertility problems, they can be injected directly into the eggs. The resulting embryos are then grown in the culture medium for between three and five days. At that point, the healthiest looking embryo is selected and implanted into the woman's uterus.

Research in cattle has shown that the type of culture medium can influence how well male and female embryos develop. A glucose-rich medium, say, seems to favour the development of male embryos and the loss of female ones.

To find out if a similar effect was seen with human IVF embryos, Jinliang Zhu and his colleagues at Peking University Third Hospital in Beijing, China, analysed more than 4400 IVF procedures that had resulted in births between 2011 and 2013. The procedures used one of four common types of culture media made by different companies, the exact content of which is a closely guarded secret.

For people that had sperm injected into eggs, the sex of their healthiest embryo – and therefore their baby – was associated with the type of culture media that had been used. For example, the

proportion of males at birth was 56 per cent for one type of medium, but just 45 per cent for another. The equivalent figure for natural births in the UK and US is 51 per cent. The association remained even after Zhu's team had accounted for possible confounding factors such as the parents' age, body mass index and the type of infertility they were experiencing (*Human Reproduction*, doi.org/2t4). The effect wasn't seen in embryos not fertilised by sperm injection. "It's a highly significant finding," says Roger Sturmey at Hull York Medical School, UK.

Zhu's team think that the male and female embryos respond differently to the mix of ingredients the different manufacturers use. It is already known that there are metabolic differences between male and female embryos – male embryos develop faster than female embryos, for example. These differences are probably down to the action of proteins coded for by DNA on the sex chromosomes.

Beyond that, it is difficult to tell what is going on or why the culture medium did not affect more naturally fertilised embryos.

"Four commonly used culture liquids result in different proportions of boy and girl babies"

"It could be down to the selection of sperm, embryo development rates, how the embryos implant, or another mechanism related to miscarriage," says Allan Pacey at the University of Sheffield, UK, who studies male fertility. The picture is further clouded by the fact that the industry doesn't reveal the composition of culture media, he says.



Not just made of sugar and spice?

In Canada, New Zealand, the UK and a number of other western European countries, it is illegal to genetically select a male or female embryo during IVF, unless there is a medical reason. But clinicians are free to choose whichever culture medium they like. "A couple reading this paper who have already got a girl might well say 'hmm, perhaps I should be using the [male-favouring] medium'," says Daniel Brison, a consultant embryologist at the University of Manchester, UK. "But it's not really a very effective method of choosing a gender."

Brison is more concerned about the other potential effects of culture medium on developing embryos. Last year, researchers at Maastricht University Medical Centre in the Netherlands found

that the culture medium can affect the birth weight of the resulting babies, and that the effect lasts for at least two years (*Human Reproduction*, doi.org/2t5). The finding is important given that a low birth weight is known to predispose individuals to chronic conditions like diabetes and heart disease later in life, says Brison.

The period of development that comes just after the egg has been fertilised is thought to be critical, genetically. Not only is it the time when the parents' genomes are shuffled together, it is also when a number of epigenetic changes – chemical modifications to DNA – are thought to take place. This might explain why slight changes to the embryo's environment during IVF can have an impact on its development. ■



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INSIGHT THE END OF COAL?

Coal bust is driving drop in emissions

Fred Pearce

THE link between economic growth and rising greenhouse gas emissions may have finally been broken. Last week, we learned that carbon dioxide emissions from burning fossil fuels failed to rise in 2014 – the first time that has happened without an economic downturn. Now we know why.

Although coal plant construction tripled globally after 2005, that boom is turning to bust. An analysis by CoalSwarm, a think tank supported by the Sierra Club and other US NGOs, has found that since 2010 hundreds of coal plant projects worldwide have been shelved or cancelled – with two abandoned for every one completed.

The amount of coal-fired power generating capacity is still increasing, but the rate of increase is down from a peak of 6.9 per cent to 2.7 per cent in 2013. “We don’t have final numbers yet, but it looks like in 2014 growth in wind power capacity exceeded that in coal,” says CoalSwarm’s director Ted Nace. “The slowdown in CO₂ is largely caused by a slowdown in

power being generated by coal.”

In 2014, the world’s energy industries emitted 32.3 billion tonnes of CO₂, exactly the same as 2013, according to preliminary figures cited by the International Energy Agency. This was despite an expansion of more than 3 per cent in the global economy. “For the first time, greenhouse gas

emissions are decoupling from economic growth,” said the IEA’s chief economist Fatih Birol. Such claims have been made before, notably after 2012, when emissions rose only 1.4 per cent against economic growth of 3.2 per cent. The decoupling faltered in 2013, when emissions rose by 2.5 per cent, close to economic growth of 2.9 per cent.

But last year the gulf between growth and emissions was the biggest yet. “These figures show green growth is achievable,” said UK climate change secretary Ed Davey.

China, which consumes half the

world’s coal, was the biggest mover. Coal has driven its economic surge, but in 2014 coal burning declined by 1.6 per cent, even as its economy grew 7.3 per cent. Its huge fleet of coal plants is now working at only 54 per cent of capacity, a 35-year low, according to Nace. “New renewables capacity exceeded new coal capacity in China in both 2013 and 2014,” says Nace. China is rejecting coal both to prevent smog, which kills an estimated 670,000 Chinese people a year, and to curb CO₂ emissions. A cap on Chinese coal burning formed part of the agreement on climate change signed by the US and China last November.

Some countries are holding out, though. Turkey, Vietnam, Indonesia and Poland are all accumulating coal-fired capacity. “But what’s striking is how quickly the business climate has turned against coal since 2012,” says Nace. The US and the European Union between them have 22 per cent less coal-fired electricity capacity than a decade ago. Yet, if not closed early, the world’s coal power stations will still pump out four-fifths of the CO₂ we can emit and still stay below 2 degrees of warming. And according to Myles Allen of the University of Oxford’s Environmental Change Institute, CO₂ emissions must fall by 2.5 per cent a year from now on to reach that target. ■



Power down: go for renewables

Glacial dimples shelter unique ecosystems

OUR planet’s ice is anything but barren. An unlikely variety of creatures lives in curious holes on the surface of glaciers – habitats made possible by wind, dust and the sun.

A team led by Krzysztof Zawierucha, from Adam Mickiewicz University in Poznan, Poland, has made the first worldwide survey of invertebrates living in these cryoconite holes. They found 25 species, many unique to this habitat, which forms when

windblown dust – cryoconite – settles on glaciers.

The Arctic is home to 16 species, with the rest distributed across Antarctica, the Americas, the Himalayas and the Alps. They include insect larvae, segmented worms, copepods and microscopic creatures called tardigrades – also known as water bears (*Journal of Zoology*, doi.org/2t3).

“In Arctic regions the big predator is the polar bear, but in cryoconite holes it is the water bear, which feeds on bacteria and algae. They are the toughest organisms on Earth,” says Zawierucha. These organisms can drastically slow their metabolism and

probably have antifreeze proteins as well, allowing them to survive the glacial winter.

“It’s very hard for anything to live within, underneath or on the surface of the glacier, so cryoconite holes are very much hubs of activity,” says Karen Cameron, from the Geological Survey of Denmark and Greenland. The holes exist because the dust is darker than the ice, so absorbs more heat. This melts the ice, forming pools with a layer of silt at the bottom.

“The organisms heat up their habitats so well that they may be speeding up the melting of the glacier”

Many of the species endemic to cryoconite holes are black, which probably protects them from high levels of ultraviolet radiation, says Zawierucha. But it may also help make their environment more habitable, as they help to heat it up by absorbing sunlight. In fact, these organisms heat up their microhabitats so efficiently that they may be speeding up the melting of the glacier itself.

“This is a significant contributor to glacial surface melt, both on valley glaciers and the Greenland ice sheet,” says Arwyn Edwards of Aberystwyth University, UK, who calls it “a biological preconditioning of a glacier to its death”. Nick Kennedy ■

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Longer heatwaves blamed on Arctic warming

READY for a scorcher? It seems our weather is getting slower – and hotter. Arctic warming is aggravating summer heatwaves across Europe and North America, by putting the brakes on atmospheric circulation.

Dim Coumou and colleagues at the Potsdam Institute for Climate Impact Research in Germany studied atmospheric circulation in the northern hemisphere from 1979 to 2013 and found that the length and frequency of hot spells in mid-latitudes had increased. They believe this is due to a reduction in the temperature difference between the Arctic, which is warming quickly, and

mid-latitudes, where average warming is slower.

This temperature difference drives the west-to-east movement of mid-latitude weather systems, such as the high-pressure systems that bring hot, dry weather in summer. A smaller temperature difference slows these systems down, making the weather persist for longer.

Coumou's team found that the frequency of stalled weather systems in summer has doubled since the onset of rapid Arctic warming around the year 2000 (*Science*, doi.org/2s6). In many cases, they stop moving for weeks at a time. That can mean long spells of hot weather that dry out soils, kill crops, empty rivers, trigger forest fires – and cause health problems. The team says this effect drove the six-week Russian heatwave of 2010, and the European scorcher of 2003 that killed 70,000 people.

Set the brain buzzing, no wires required

IT'S time for a shake-up. There is a new way to stimulate the brain, using tiny vibrating particles.

The technique is a twist on deep brain stimulation, which involves sticking electrodes into the brain to prompt neurons to fire. It has shown promise for treating illnesses including Parkinson's and depression, but can't be done without invasive surgery.

To see if she could take the

electrodes out of the picture, Polina Anikeeva at MIT turned to cellular receptors called TRPV1. These make nerve cells fire when exposed to high temperatures or the heat created by eating chillies. What if it were possible to remotely stimulate the receptors?

One way of doing this is to inject magnetic nanoparticles into the brain and apply an oscillating magnetic field. As

the jostling nanoparticles align with the field, they give off heat that TRPV1 receptors on neurons pick up – causing them to fire.

Anikeeva's team tested their technique on three mice. A month later, the nanoparticles – which are approved for use in people – were still able to stimulate the brain. The team are now monitoring the mice to see how long the effects last and how safe the technique is in the long term (*Science*, doi.org/2s4).

Heart drug reduces cancer spread risk

CANCER is cruel: sometimes, life-saving surgery to cut out a tumour may help it spread in the body. There could one day be a drug that reduces this risk.

A few years ago, a team led by Takashi Nojiri of Osaka University in Japan was exploring whether giving a molecule called atrial natriuretic peptide (ANP) before lung cancer surgery could reduce subsequent heart problems.

It did, and it also had another benefit. Two years later, 91 per cent of people treated with ANP were free from secondary tumours, compared with 75 per cent of a control group. The drug makes blood vessel walls less sticky, preventing cancer cells from adhering and squeezing through the walls to form new tumours. ANP occurs naturally in the heart, so this may explain why secondary tumours are rarely found there, says Nojiri (*PNAS*, DOI: 10.1073/pnas.1417273112).

Spiders find their mummy yummy

MOTHERHOOD is no bed of roses, and for some it can be deadly.

Regurgitated food is not enough for young *Stegodyphus lineatus*. These velvet spiders eat their mother, an act called matrophagy, and she doesn't seem to mind. In fact, she prepares herself for it. Her abdominal tissues start to break down before the young hatch, making her more palatable for when the babies are 2 weeks old (*Journal of Arachnology*, doi.org/2s8).

This meal may give her young a head start in the desert. The mother's ovaries wait longer before breaking down, says study leader Mor Salomon of the Hebrew University of Jerusalem, Israel, which may let her make more eggs if things go wrong.

Moon's buried scars unmasked

THE moon has hidden scars from an explosive past. Ground-penetrating radar on China's Yutu lunar rover has uncovered ancient lava flows and evidence of past eruptions.

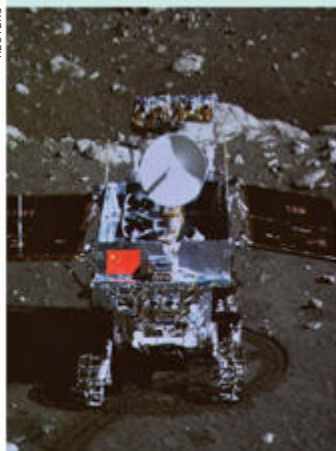
Yutu launched in 2013 as part of the Chang'e 3 mission, China's first lander on the moon. It touched down on the Mare Imbrium, a vast flat crater thought to have been formed 3.8 billion years ago by a large meteoroid impact.

As Yutu zigzagged along the crater, its radar was able to peer down to 400 metres below the lunar surface. It found evidence for five distinct volcanic events, some of which appear to have been explosive eruptions rather than gentle lava flows.

The third lava layer down, about 240 metres deep and 3.3 billion years old, has a random, angular texture similar to what is produced on Earth when violent eruptions eject large rocks. Earlier probes found evidence of basaltic lava only, which flows more gently.

Explosive eruptions require a lot of gas to help drive them. This suggests there might be volatile substances like water in the moon's interior (*Science*, doi.org/2sp).

Mechanical problems mean Yutu is stuck, although it is still gathering some data. Another rover is planned for this year, ahead of a sample return mission in 2017.



Quasar backlighting doesn't flatter Andromeda's figure

OUR galactic neighbour put on weight overnight. Faraway quasars have let us map the Andromeda galaxy's flimsy outskirts for the first time, revealing huge amounts of previously unseen gas.

Quasars, the brilliant cores of distant active galaxies, shine out through a "fog" of material closer in, so can serve to probe the contents of nearby galaxies. But finding more than a few quasars behind each galaxy isn't easy. Now Nicolas Lehner of the University of Notre Dame, Indiana, and his

colleagues have used a record 18 quasars to study our nearest large galaxy: Andromeda, or M31.

Computer simulations suggest that, in addition to mysterious dark matter, M31 should contain more ordinary matter than what we can see as stars. Astronomers suspected it was in the form of gas, but had not been able to detect it directly.

Lehner and his team looked at the way the quasars' light was absorbed by silicon at M31's fringes, and so estimated how much mass these outer reaches

contain. "We found at least 40 billion solar masses in the gaseous halo," says Lehner – a significant boost to the amount of regular matter in the galaxy (arxiv.org/abs/1404.6540v2).

The finding has implications for how galaxies collect material over time. "This research helps to constrain the physical processes related to such accretion and also the opposite process: the expelling of gas and metals from within galaxies," says J. Xavier Prochaska at the University of California, Santa Cruz.

Ice your CubeSat for rocket fuel

ICE would make a fine rocket fuel, if you're a CubeSat.

These lightweight, low-cost satellites are made up of 1-litre modules, making them popular for student projects. But they are limited by the lack of a good propulsion system to keep them aloft longer and under control, says Angelo Cervone at Delft University of Technology in the Netherlands. "We have reached the maximum level of what you can do with small satellites without one."

So Cervone and his colleagues designed an ice-propelled rocket. The CubeSat would contain 100 grams of water ice. Once in space the ice sublimates, releasing vapour molecules. These would bounce against a hot plate to gain speed, creating a propulsion force (*Acta Astronautica*, doi.org/2sv). A prototype may fly in a few years.

Ice-powered propulsion could work well, says Paulo Lozano, director of the Space Propulsion Lab at MIT. "It's based on solid propellant, and that is always a good idea," he says. "If you have something that can explode, it would pose a threat to the main payload. The challenge will be to keep the ice as ice all the time."



Velvet worm's sticky secret revealed

THIS worm can give Spiderman a run for his money. Using special glue cannons, it shoots out sticky webs that harden in seconds – ensnaring predators and prey alike. Now the secrets behind the worm's superhero talent have been unlocked.

Andres Concha at Adolfo Ibanez University in Chile and his colleagues used high-speed cameras to study the worm's cannons in action. They found that pressure builds up as glue from a large reservoir behind the worm's head is forced through the narrow gun barrel. The pressure causes the pipe, which has no rigid

supports, to jump about wildly while it discharges its payload, like a high-pressure hose. This generates sideways motion at speeds 25 times faster than muscles could produce (*Nature Communications*, DOI: 10.1038/ncomms7292).

The insight could help us design a range of products, from inkjet printers to better drug delivery systems, says Concha. Victoria Haritos at Monash University in Melbourne, Australia, sees potential for use in gels that could stop people in their tracks, replacing tasers, or to stick wounds together.

“YOU NEVER REALLY UNDERSTAND YOUR SUBJECT UNTIL YOU HAVE TO COMMUNICATE IT...”

Nominate your peers for Elsevier's new award for outstanding next-generation science communication

The crossroads in Mark Miodownik's career came in 1999 when as a young researcher he gave a talk at a materials science conference in Boston. “Afterwards a senior scientist said he thought I was doing good work but that I ought to stop making it sound so interesting,” recalls Miodownik. “He seriously said that and it changed my career path – I decided to do the exact opposite.”



Vicky Forster

The rest is scientific history. Miodownik began communicating the excitement he felt for materials science to a broader audience. Since then, he has given numerous public lectures, made several TV series about materials science and gave the Royal Institution Christmas Lectures in 2010. He is widely credited with giving a new lease of life to the public perception of materials science.

Miodownik is an aspirational example for the new generation of young scientists for whom science communication is an increasingly important skill. Many young researchers are experimenting with novel forms of communication to bring scientific research to a broader audience. They're using blogging, youtubeing, tweeting and scientific social media such as Mendeley. That's in addition to traditional channels such as public speaking.

These forms of communication are having an increasingly important impact on the way the public engages with science. And they are also changing the way scientists themselves work.

To encourage and reward this activity, the scientific publisher Elsevier is running a competition to find the next generation of outstanding scientific communicators and honour one of them with a new prize.

The competition is part of Elsevier's worldwide programme to support young scientists through the most challenging parts of their careers. The new prize is called the Researcher's Choice Communication Award 2015 and Elsevier is looking for nominations for

anyone who fits the bill (see Competition: Calling science communicators, below right, for how to enter).

There is no shortage of young scientists who fit the bill. When Vicky Forster received her PhD from Newcastle University in 2012, she tweeted a message announcing the award. “Dear Cancer I beat you aged 8, and today I got my PhD in cancer research. Take that.” The message was warmly greeted by friends and colleagues and quickly became viral, being retweeted more than 12,000 times.

Vicky is a leukaemia survivor. And it is no coincidence that today she is a cancer researcher studying the way genetic mutations can cause cancer and why cancer drugs can cause severe side effects in some people but not in others. “In an odd way, my leukaemia experience gives me an insight into research. I can talk about my experience in a scientific way, which makes the science more accessible,” she says.

Vicky's science communication activities are formidable. She writes a blog for Leukaemia & Lymphoma Research, the UK's biggest blood cancer charity. It is a useful platform for discussion and information sharing. She has taken part in several Skeptics in the Pub events, chatting in bars to all comers about alternative cancer treatments.

In July last year, she gave a TEDx talk about one of her heroes, Janet Rowley, who helped develop the first targeted cancer treatment. And then in August she spent a month on the science desk at *The Times* writing more than 25 articles on a broad range of science topics. “They threw me in at the deep end and it was brilliant,” she says. “If I can stay in research and write occasionally, that would be perfect.”

Of course, Vicky isn't the only young scientist taking up the baton. Suze Kundu received her PhD from University College London (UCL) in 2012 having studied artificial photosynthesis, focusing on capturing sunlight using



Mark Miodownik



nanocrystalline titanium dioxide. During that time and since, Suze has been swept up in a science communication whirlwind. "It's a strange journey I've taken," she says.

Her first experience of academic public speaking was terrifying. She recalls presenting her work at a meeting of the American Chemical Society in Anaheim, California, and gripping the podium so tightly that her knuckles turned white. "I remember calculating where I'd fall if I fainted and whether I'd hurt anyone in the process."

To combat this fear, she signed up for a competition at UCL called Tell Us Your Thesis, where students talk about their work in just a few minutes. "That gave me some confidence. It was a good way to face my fear," she says.

Since then she's done scientific stand-up

comedy, completed a science policy fellowship at the Houses of Parliament, given chemistry lectures about how to mix drinks and worked as a researcher for the BBC programme *Wonders of Life*.

Suze has become so involved in teaching that in 2012 she became a teaching fellow at Imperial College London. "Not everybody enjoys teaching but I seem to be OK at it. I'm qualified to do it and I love it too," she says. Her advice for others who also fear speaking in public? "The

best thing is to face the fear," she says. "What's the worst that can happen?"

Rowena Fletcher-Wood says there are other advantages to writing. She has authored several blogs since she started her PhD in chemistry at the University of Birmingham in 2011. "I'm a serial writer," she says. The positive feedback she's had from this work gave her the confidence to write a science play, which she put on at the University of Birmingham with funding from the Royal Society of Chemistry.

That's opened up a number of opportunities, including an audition to do some acting for a murder mystery company. She hopes to get her PhD in the next few months and has a good idea of what she wants next. "I'd like to move full time into science communication," she says.

One theme common to all these people is how widely useful the skills are. Rowena says it is important to learn how to communicate complex ideas not just to the public but also to colleagues in other disciplines. "That has an impact on multidisciplinary research," she says.

These forms of communication are changing the way scientists work. Vicky points to how she can get tips about how to do assays or grow cells by tweeting questions. "In the past, you'd have to find out if anybody in the department knows somebody who can help, then email them and wait for an answer that might arrive a few days later...if you're lucky," she says. "A tweet can get you an answer in minutes."

For Miodownik, the importance of science communication is clear. "You never really understand your subject until you have to communicate it. I'm a better teacher and a better scientist as a result."

The bottom line is that communication is becoming a core skill for a new generation of young scientists. If you know anybody who excels at this, enter them for the Researcher's Choice Communication Award 2015 through mendeley.com. What's the worst that can happen?

Enter the competition at:
www.mnd.ly/scopusawards

"I'm a better teacher and a better scientist as a result of my communication work"

Mark Miodownik



Suze Kundu



Rowena Fletcher-Wood

COMPETITION: CALLING SCIENCE COMMUNICATORS

Do you know any young scientists who are brilliant at communicating scientific ideas to a broad audience? If so, nominate them for the Researcher's Choice Communication Award 2015 and they could win £1500. Award organiser Elsevier is looking for young scientists who excel in all forms of scientific

writing, speaking and public engagement and particularly at:

- Addressing misleading information about scientific or medical issues in any forum;
- Bringing sound evidence to bear in a public or policy debate;
- Helping people to make sense of a complex scientific issue.

Nomination is through the Mendeley Scopus Awards page www.mnd.ly/scopusawards. Just enter the researcher's name, age, institute and the reason for the nomination along with links to supporting evidence such as a blog, twitter account or Youtube video. Nominees must have

begun publishing no earlier than 2012, live in the UK and be affiliated to a UK institution.

The winner will be announced at the Scopus Young Researcher UK Awards in November. For more information see www.mnd.ly/scopusawards. Good luck!

Five big challenges facing the NHS

With less than 50 days to go until the UK general election, politicians of all stripes are proclaiming that they know how to fix the National Health Service. But as with public health services all over the world, the real game-changers the NHS faces are far more profound. *New Scientist* investigates what we need to do to prepare



There may be trouble ahead

STEFAN WERNUTH/REUTERS

DRUG RESISTANCE

The antibiotic apocalypse

At the last UK general election, the threat of antibiotic resistance was barely a blip in the public consciousness, let alone occupying the thoughts of politicians. That changed in 2013, when Sally Davies, the chief medical officer for England, publicly warned of the apocalyptic scenario – on a par with global warming, she said – of running out of drugs. It is happening because bacteria evolve to survive antibiotics, even when they are used properly, and new drugs aren't being developed fast enough to replace ones that are becoming less effective.

Infections resistant to antibiotics kill at least 25,000 people in Europe annually. Moreover, antibiotics to prevent incidental infection are essential for many medical procedures, from operations to cancer treatment. These will become difficult, or impossible, to carry out as resistance rises. An independent panel appointed by the government last year has estimated that if new treatments do not become available, global deaths could soar to 10 million a year by 2050 at a cost to the economy of \$100 trillion.

Even in the near future, the UK's share of that cost could cripple the already cash-strapped NHS. Patients with drug-resistant infections need to stay in hospital for longer and even if newer drugs exist, they are often more expensive and have more side effects. Then there are the costs of hospital-wide emergency measures to stop the spread of "superbugs" like MRSA.

To tackle the problem, the panel called for five measures. One is a pot of government and philanthropic money to develop new anti-microbial drugs and bring them to market. It also called for efforts to make existing

drugs go further by reviewing the recommended doses or combining drugs to more effectively kill resistant bacteria.

The panel also wants to take the guesswork out of diagnosing infections. It can be almost impossible to tell if some infections are viral or bacterial from symptoms alone. Technology such as IRIDICA, a diagnostic platform approved for use in Europe in December, could help match the drug to the bug. It can distinguish a thousand types of pathogen in a matter of hours.

Such new technology won't be enough to solve the problem, says Richard Smith of the London School of Hygiene and Tropical Medicine. Doctors must learn to conserve antibiotics, old and new, and the effort must be global. However careful a doctor is with antibiotics, uncontrolled use elsewhere spawns resistant bacteria that spread everywhere. **Debora MacKenzie**

INEQUALITY

It's all about the money

If the low rates of cancer seen in the richer portion of UK society were replicated across the nation, 19,200 fewer people would die every year. It is a shocking statistic, and one that isn't restricted to cancer: across almost every measure of health, those with less money get more disease.

It is tempting to frame this as a problem of poverty: if everyone could afford to eat wholesome food and join a gym, disparities in health would diminish. But this is only partly true. Economic inequality can also cause anxiety about social status for those with less, which can lead to chronic stress that weakens the cardiovascular and immune systems, says Richard Wilkinson of the University of Nottingham. This is bad news for the NHS given recent forecasts that predict

inequality in the UK is set to grow.

The last two governments have recognised the need to reduce inequalities in health. Since 2004, the NHS budget has been distributed so that deprived areas and poverty-related health issues such as smoking and obesity receive more money. The system is being redesigned to give even more weighting to deprivation.

"Tackling health inequality means tackling wealth inequality but politicians lack the courage to do this"

"Everyone should have the opportunity to live a healthy life no matter what their background is," said a Department of Health spokesperson.

However, it is less clear that politicians fully appreciate the impact that income and wealth inequalities have on these health disparities. When it comes to redressing the income imbalance, the focus on individuals rather than on making a wider change to society is frustrating, says Kate Pickett of the University of York. Reducing wealth inequality could be achieved by taxes that go up more as income increases, for example. The importance of such measures was highlighted by the independent Marmot Review on health inequalities in 2010, but Pickett believes all political parties lack the courage to tackle such issues head on, despite the known costs of inequality. **Michael Bond**

LONGEVITY

Ageing society's greater burden

Sixty may be the new 40, but will 80 ever be the new 60? It will need to be, if the NHS is to support a changing population.

When the NHS was founded in 1948, nearly half the population died before the age of 65. Now only 14 per cent do. By 2035, the over-65s will make up 23 per cent ➤

WORLDLY ADVICE

Similar challenges face healthcare systems around the globe. Some countries have come up with clever solutions that could benefit others.

INDIA

Treating a hospital like a factory might not sound a promising approach, but it is one way to make complex heart operations more efficient without increasing risks. The Narayana Hrudayalaya health system in Bangalore has improved its cardiac surgeries by copying Japan's approach to car-making. By allocating the various preparatory and surgical stages to teams with relevant skills and training, the region's main hospital now conducts more surgeries than some top US sites, with equal or better results.

SWEDEN

Communication is everything. After an elderly woman with breathing difficulties had to talk to 36 healthcare workers before receiving treatment, the County Jönköping Council in Sweden decided to reform how it deals with elderly patients. By getting different parts of the health system to talk to each other, they were able to coordinate and simplify the path to treatment. Admissions were cut by almost 22 per cent over five years, and many waiting times for referrals have dropped from 48 days or more to just two weeks.

CUBA

Cuba does more with less. Despite having been under US sanctions for decades, people in the country have similar life expectancies to US citizens. The island has one of the highest concentrations of doctors in the world, with a family physician living every four blocks, seeing patients from their house, serving about 300 local families. Regular visits mean health problems tend to be diagnosed early and vaccination rates are among the highest in the world.

Penny Sarchet

SOUNDBITES

Which scientific advances will help tackle the problems the NHS faces?

"Top of my list is genomic medicine. The 100,000 genomes project could make us world leaders in comparing genotypes and phenotypes, which will assist the treatment of current patients and provide lifestyle advice for future generations. Early success for relatively low investment is within our reach."

Robert Naylor, chief executive of University College London Hospitals

"Some way of enabling patchily applied knowledge to be applied consistently would yield the greatest benefits. Call it improvement or reliability science. Variation is the Achilles' heel of the NHS and, indeed, all Western health systems."

Bob Young, diabetologist at Salford Royal NHS Foundation Trust

"The number of older people with at least three separate conditions is expected to rise from 1.9 million in 2008 to 2.9 million by 2018. Living longer in poor health doesn't seem a very attractive prospect. Science is trying to address individual conditions, but this needs to expand to include the combination of conditions. This would enable older people to maintain their independence for longer."

Jane Collins, chief executive, Marie Curie Cancer Care

"Our best hope is to learn how the complex system that is society can create wellness. The way we organise ourselves socially and economically determines outcomes, not just in health but in all spheres of life. Positive well-being outcomes are achieved by myriad influences. Understanding how they interact and, more importantly, the methods that might be used to change the outcomes of this complex system will be essential."

Harry Burns, professor of global public health, University of Strathclyde

of the population. "For the vast majority of chronic diseases, age is the single biggest risk factor," says Tom Kirkwood at Newcastle University's Institute for Ageing.

The main problem is that the health service is designed to treat single-organ diseases, but most elderly people have more than one medical condition. Work by Kirkwood's group – the biggest longitudinal study of health in the over-85s in the world – found that 75 per cent of people in this bracket have four or more age-related diseases. However, almost all guidelines are disease specific and based on clinical trials involving younger people with a single condition, says David Melzer at the University of Exeter, which means that treatments might not work as expected. The lack of "joined-up" care for combinations of conditions is also a problem, says Kirkwood.

The NHS is aware that change is needed. "We've got to move away from health services that are predominantly reactive and waiting for something to go wrong," Simon Stevens, chief executive of NHS England, told a conference on ageing and health at Chatham House in February. He said that GPs are well placed to plan and coordinate the kinds of care needed before things go wrong. Pharmacists could play a role too. "Things never tend to get taken off the prescription list, which just gets added to," says Kirkwood. If pharmacists were empowered to review and manage a person's drug cocktail, health and budgets could both benefit.

To ensure the future health of the NHS, younger generations need to age more healthily than previous ones. This means focusing on the lifestyle risk factors that we know have a strong effect on health, such as smoking, poor diet, being overweight and low physical activity, says Elaine Rashbrook of advisory body Public Health England. "If you're active earlier in life, you're above the disability threshold for longer

because you've built up that strength earlier on," she says.

Kirkwood believes we can do a lot to contain rising costs by being more effective in the way we deliver care. "It's a challenge, but it's not something that should have us quaking in our boots."

Penny Sarchet

WEARABLE TECHNOLOGY

Your data in your hands

If handled well, the rise of the digitally empowered patient could fulfil the wildest dreams of NHS policy-makers: a fitter, happier, more engaged public that sees the doctor less often. And when patients do make contact, they come armed with a diagnosis and data to back it up.

Apps and wearable technology already exist that can monitor sleep quality, calories, heart rate and physical activity. Soon we'll be able to track blood pressure, glucose levels, blood oxygen content, respiration rate and temperature, not to mention emotional well-being. It won't be long before smart devices will be detecting molecules in bodily fluids and diagnosing a complex array of conditions. "Within 10 years, I am

quite sure that most smartphones or other gadgets will be able to do a serious amount of diagnosis," says Charles Lowe, president of telemedicine and eHealth at the Royal Society of Medicine.

That's the dream, at least. But if what your watch or armband tells you causes anxiety, is hard to understand, or if there is a high rate of false positive results, the NHS could be overwhelmed. And if there is a high rate of false negatives, then people will be misleadingly reassured and so not see a doctor when they need to.

So what can be done to ensure the technology complements the NHS? The National Information Board was set up last year partly to investigate how digital services can "support prevention and self-care". "We want to encourage people to be part of the social movement that is actively encouraging healthy behaviours," says Tim Kelsey, NHS director for patients and information.

A major goal is to provide people with a list of NHS-endorsed apps and eventually other self-care devices. The idea is that endorsement will allow doctors to trust and prescribe apps. To get to this point, independent trials will be needed to establish the efficiency of each



Forearmed is forewarned

one. "We need to know what the benefits are of the apps and devices," says Lowe, who wants an app-testing equivalent to the randomised clinical trials used to assess drugs. "Once they've done it for apps, they can do it for wearables, and everything else."

"Within 10 years, phones and other gadgets will be able to do a serious amount of diagnosis"

When there's a set of high-quality apps and gadgets to choose from, the next task is to ensure the support systems are there to deal with the data these technologies create. These could include smart analytics that trawl through patient-generated data and alert the doctor to anything amiss. Or 24-hour support for products that send the data directly to the patient. This could be in the form of a website, a call centre staffed by medical professionals or even just an algorithm. "As long as you get good advice, after a while you probably wouldn't care or notice whether it was a human doctor or a computerised doctor on the other end," says Lowe. **Jessica Griggs**

CLIMATE CHANGE

The rising threat of heat

It has been called the single most important public health issue of the 21st century. Climate change is a challenge for UK healthcare, not just because it could bring nasty insect-borne diseases closer to the country's shores, but because of the way it will exacerbate existing problems, such as the deadly effect of heatwaves, particularly on the elderly.

Average UK temperatures have been rising by about 0.25°C a decade since the 1960s, and they are projected to be between 2°C and 5°C higher still by 2080.

Death rates go up in the days following peaks in temperatures and air pollution. Although people rarely die of heatstroke itself, high temperatures can make you more likely to die of an existing heart or lung condition.

Air pollution fluctuates with the weather and temperature. It raises the risk of asthma attacks and pneumonia, which can result in early death. Life-long exposure to pollutants also increases the odds of lung cancer.

There are things we can do to reduce these risks, besides preparing doctors for changes in the number of patients. For instance, in 2013, the NHS published a heatwave plan with Public Health England, which included provisions for moving certain patients to cool rooms when the weather heats up. You could even envisage municipal cool spaces for pedestrians to cool off in, says Sonia Roschnik of the Sustainable Development Unit, an NHS spin-off that aims to ensure the sustainability of the healthcare system.

Reducing the number of people needing to go to hospital would also help. That could involve things like phone apps that warn you when pollution or pollen levels will be high. Staying in touch with people who become depressed could also help, because climate change is expected to affect mental health. For example, after a flood, displacement and the loss of a home can bring on depression, especially in less-affluent regions. And droughts have been shown to increase depression in those whose livelihoods rely on the weather.

These factors and more are being considered as health professionals and researchers look at how to future-proof healthcare infrastructure. They are, for instance, thinking about how best to build new hospitals and how to make sure existing ones are right for the climate. The wheels are in motion, but so is the warming. **Catherine Brahm**



BSIP/SAVALAMY

Best practice is hard to spot

Why success can be difficult to replicate

THE winter crisis was particularly severe for the National Health Service this year. Hospitals across the UK struggled to cope: there were reports of patients being seen in marquees and even one kept in a stock room.

There were some exceptions. About 98 per cent of people arriving at the accident and emergency department of Luton & Dunstable University Hospital in Bedfordshire were seen within 4 hours - compared with 88 per cent for England as a whole.

What the hospital did wasn't rocket science. Delays tend to start on the wards - often with older people who no longer need to be there medically but who are too frail to go home without additional care. Luton now monitors the number of patients in all departments, so extra staff can be sent to where they're needed and social services can be enlisted to find nursing home places.

You might think that next winter every UK hospital will follow Luton's lead. But that's unlikely. Doctors and hospitals do things differently in nearly all areas of medicine, and until recently there has been little effort to find out what works best. And star performers cannot be emulated if no one knows who they are, or even what constitutes star performance.

Things are starting to change, says Chris Ham, who heads the King's Fund

think tank. The country's independent health regulator, the Care Quality Commission, gives ratings to hospitals on the basis of factors such as waiting times, infections and death rates. Standardised patient surveys have been introduced for a few types of surgery. And people can now look up a surgeon to see how experienced they are and whether their results are in line with the national average.

When it comes to the NHS, though, policy-makers also have to take public opinion into account - which can be at odds with the data. For instance, there is good evidence that for some specialised areas of medicine, such as stroke, serious injuries and children's heart surgery, the best results are at dedicated centres, where staff see so many cases they are expert. "Practice makes perfect," says Ham.

The logical conclusion is that for these conditions, care should be provided by a few large centres, and that smaller units should close. But efforts to shut down a children's heart surgery unit in Leeds, one of several in the north of the country, to centralise services in this way have so far been thwarted by a public outcry.

Efforts to measure NHS performance are still incomplete, and sometimes bitterly fought against. Still, they are a start, says Ham.

Clare Wilson

BIG LANDSCAPES INSPIRE BIG THINKING

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Dr Louise Wong,
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Tell us a little about yourself

Well played, you're hired

Playing games could help screen the best candidates for plum jobs, says **Hal Hodson**, and help make recruitment a fairer process

HATE writing covering letters? Fall to pieces in interviews? Not to worry. Soon the top candidates for a job will be chosen by how well they play video games.

Last week a company called Starfighter was launched. Its aim is to create games you can only master if you have a talent for programming, although those with a natural aptitude can learn as they play. If you do well in a game, the firm knows you are ripe for hiring.

Starfighter's games will have a story. "You'll pretend you're a spy for the day, for example," says Patrick McKenzie, Starfighter's CEO and co-founder. "The story might be to break into tech that's securing state secrets, but it's the same tech you'd use to secure a bank in the real world."

The assumption is that the players who are best at breaking into the software in the game will

also be the best at securing it in the real world. Starfighter works with top players to place them in jobs fitting the skills they have demonstrated, if they want them.

The post announcing Starfighter is unequivocal: "Becoming a top Starfighter player is a direct path to receiving lucrative job offers from the best tech companies in the world, because you'll have proven beyond a shadow of a doubt that you can do the work these companies need done."

Starfighter's games will be totally free, and while they won't have fancy graphics, they will be engaging to play just for fun. Starfighter isn't ready to talk about exactly which skills their games will test, but its founders have already built a game called *Microcorruption*. It imagines a scenario in which players must break into locked warehouses all

over the world, each one stuffed with cash. A smartphone app controls each warehouse lock, and the players have to break in without knowing the code. Of 12224 players, just 182 passed the hardest level. The firm will get in touch with these elite players and help place them with one of their clients, who pay Starfighter a fee.

"Those best at breaking into the software in the game will also be best at securing it in the real world"

Recruiting new blood through games lets companies search for talented individuals based on more relevant criteria than which college they went to, or what their grades are. But using games has another benefit: it can prevent discrimination.

The benefits of this screening have proved worthwhile in a

completely different arena – auditions for professional orchestras. In the 1970s and 1980s, orchestras began to put candidates behind a screen during auditions. Until then just 5 per cent of the players in the top five US orchestras were women. Today, that number is 25 per cent.

Meanwhile Knack, a company based in Palo Alto, California, is developing smartphone games that build up profiles of gamers as they play, measuring things like leadership ability, problem-solving and planning. Those profiles can then be matched with employers looking for similar traits.

"We try to give job recommendations in the same way as Netflix recommends films," says Guy Halfteck, Knack's founder and CEO.

The White House has turned to Knack for Barack Obama's TechHire initiative. The idea is to use Knack's system to help minorities, women and veterans land technology jobs which might normally be closed to them.

Halfteck says Knack has patents that cover inserting its technology into other games, too. This opens up the possibility that gamers who demonstrate high competence in *Halo* or *League of Legends* could be recruited right out of their favourite game.

Patrick Gormley of New York-based management consultancy Capco, says his firm is about to start pulling recruits out of Knack's pool of gamers. The firm got its own top-performing project managers to play the games, building profiles that they can then compare with all the players in Knack's system. When the system finds matches, it will send a text telling players they've been matched with a job at Capco, and asking if they want to apply.

"If you're getting a ping you should be very excited," says Halfteck. "It means you're pre-qualified. You are steps ahead of everyone else. You already have potential for success." ■

Let Charles Dickens sort out your passwords

IT WAS the best of times, it was the worst of times, then you forgot your password and it totally went to pot. Thankfully, a way of generating secure but memorable passwords based on the work of Charles Dickens – or indeed any large text – will make things far better.

People are terrible at choosing passwords – “123456” and “password” are among the most used – so ideally we should randomly generate them. Something like “TH9H*kt7” is very secure because the mix of upper case, lower case and special characters makes it just one of 72 quadrillion possible 8-character passwords, and hackers often start by guessing words.

But it's hard to remember that garbled mess. That's why John Clements of California Polytechnic State University in San Luis Obispo has turned to Dickens. He used a tool from probability theory called a Markov model. The model looked at pairs of characters – letters and punctuation, not fictional people – in the book *A Tale of Two Cities*, and saw how often other characters appeared after them. Taking “ca” as an example, “car” is more likely than “caf”.

To build passwords, the model takes two characters and generates a third. The second and third characters are then put back into the model to give a fourth, and so on until you have a password that is long enough to be secure (arxiv.org/abs/1502.07786).

The passwords contain words that seem memorable and pronounceable, even if they aren't real English, such as “Therying hant abree.”. Starting with three characters or more instead of pairs results in more familiar words, at the cost of length, giving things like “The shing it nother to delve w”.

These passwords are just as secure as “TH9H*kt7”, and hopefully easier to remember. Clements plans to explore using a person's email history to generate passwords, so they will be based on personal idioms, rather than those of Dickens. Jacob Aron ■

WINGBEAT/ROBARA



Game of thrones

Falcon vs drone

The ancient royal sport of falconry is embracing high-tech hunting, with falconers using machines to train birds of prey, finds **Aviva Rutkin**

THE first time Paul Mascuch's falcon saw a drone, she didn't know quite what to make of it.

Mascuch, an experienced falconer in Parma, Idaho, was nursing the bird back to health after she had suffered a broken wing. The quadcopter, which Mascuch had fitted with blade guards, was placed on the ground next to his falcon. She eyed it warily. As the motors started up, Mascuch distracted her from the noise with a snack.

Soon the bird was up in the air, chasing the drone – and the half a quail dangling from it. Her owner is now a drone convert. “It's easy to use, quick and very versatile,” says Mascuch. “If you have a bird that's difficult [to train], these tools make it easy.”

Drones have taken the ancient sport of falconry by storm over the past few years. Falconers train their birds to reach high altitudes, so that they can see across larger areas and are more likely to find

prey. Traditionally, they have done this by rewarding the falcon whenever they happen to fly high. Some trainers tempt the birds upwards with bait attached to a kite or balloon. But drones offer more control over this process – they can make the bait fly where the trainer wants or hover, even in a stiff breeze.

Wingbeat, a falconry company based in Carmarthen, UK, has

“If robotic falconry catches on it might help protect endangered game like the houbara bustard”

built a drone called the Robara. Designed to resemble the houbara bustard, a game bird frequently hunted by falconers in the Middle East, the Robara has a foam head and flapping wings, and flies at the speed and height of a real houbara. It is set to go on sale in the Middle East in September, in time for the hunting season.

But the drones don't appeal to everyone. Real falconry means hunting wild game in the field, says Tom Cade, founder of conservation group The Peregrine Fund in Boise, Idaho. “If you want to go artificial, if that makes you happy, that's fine,” he says. “But please don't call it falconry.”

Nick Fox, a falconer who has bred birds for the royal families in both the UK and Abu Dhabi, is director of the Robara project. He says robotic falconry could be turned into a competitive sport. If it catches on, it might help protect houbaras in the wild, where they are at risk of extinction.

“To the average person, it would seem like this great leap forward, but it's really an evolution of what falconers have done for a long time,” says Mike Dupuy, a falconer in Pennsylvania who plans to incorporate drones into his training. “It's a beautiful thing, it's a new thing and I think we're going to get a lot more of it.” ■

Baby bump sensor belt lifelogs before birth

TALK about early adopters. The next generation could start lifelogging even before they are born. A wearable device lets expectant mothers listen in on their developing baby's heartbeat and movements continuously, rather than just when she goes into the hospital for a scan.

The device consists of a lightweight harness with sensor-laden straps that go over and around the bump. Its inventors believe the system will offer peace of mind to pregnant women, as well as help doctors to monitor high-risk cases remotely rather than keeping women in hospital for observation. It might even reveal new insights about pregnancy itself.

Technology for monitoring fetal health at home already exists, but it tends to be tricky to use because you have to move the device around to find the fetus's heartbeat. "The baby's heart is about a centimetre in size. It's inside of the baby, inside of the uterus, inside of the liquid. It's moving constantly," says Oren Oz, CEO of Nuvo Group, the Israeli company behind the device.

The first version of the belt, called Ritmo, is designed for women to buy and use themselves and will go on sale by the end of this year. It will have 13 sensors wrapping around the belly, including acoustic and ECG sensors to monitor the heartbeat, with motion sensors to track kicks, contractions and other movements. "We record everything possible from the surface of the abdomen about the pregnancy," Oz says.

The information is sent to a cloud server for processing, and the results are sent back to the user's smartphone. This should reassure them that the fetus is still alive and kicking, even if it hasn't been moving much - because it is sleeping, for instance. It should also allow people to chart how certain activities - like listening to music or meditation - affect the heartbeat of mother and fetus. The device, which was

previewed at the Wearable Technology Show in London last week, will cost \$200 to \$250.

Rachel Tribe, who studies women's health and pregnancy at King's College London, agrees that this device has the potential to be

"High-risk pregnancies can be monitored remotely by the belt, so women won't have to go to hospital"

helpful. But she cautions that round-the-clock monitoring could cause anxiety for some women. "The use of all self-monitoring devices brings dangers of both increasing unnecessary anxiety and giving false reassurance, so the device would require rigorous clinical testing before it could be safely used," she says.

Nuvo Group is planning a medical

grade version of the device, called Pregsense, which will have more sensors and better accuracy. With approval by the US Food and Drug Administration, Oz says, doctors could use it to monitor patients remotely and pick up any complications early.

Oz hopes the data these devices generate will lead researchers to new insights about pregnancy, as well as providing personalised predictions for women. The team might be able to warn a woman that she is under too much stress, for instance, and needs to change her eating and sleeping habits to avoid complications. "We'll know that if you continue that way, you are going to end up in hospital. Why? Because we will have measured 100,000 women and 95 per cent of them following the same trajectory end up in hospital if they don't change now," says Oz.

The team would then be able to offer advice and see whether it helps. "That's where it gets really exciting," says Oz. "This is predictive, and this is where you can actually save lives." Catherine de Lange ■

RITMO/NUVO GROUP



What's going on in there?

ONE PER CENT



Museum of Stolen Art

Stick the goggles on and experience some illicit culture. The Museum of Stolen Art, created by Ziv Schneider at New York University, is a virtual museum you explore wearing a VR headset. It contains photos of art the FBI and Interpol have reported as missing. One wing of the museum contains stolen paintings, while another has artworks that were looted during the Iraq invasion in 2003.

"Have you ever been in love?"

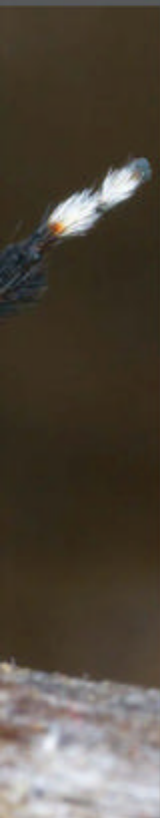
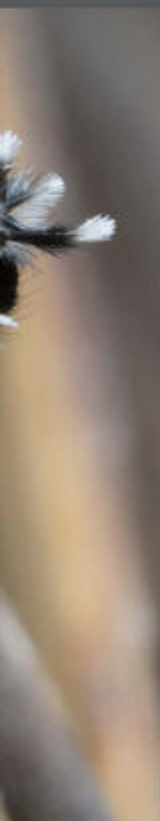
A question asked by an automated Tinder account at last weekend's SXSW festival in Austin, Texas. Once prospective dates engaged with the account, they unwittingly took part in a conversation with an AI. The stunt was designed to promote the sci-fi movie *Ex-Machina*.

Pencil lines as sensors

MacGyver would be proud. Drawing a rectangle on a piece of paper with an ordinary pencil can create a sensor. As the graphite rectangle bends with the paper, its resistance either increases or decreases. By measuring that resistance, the precise angle of the bend can be detected. The idea could lead to flexible, lightweight sensors for smart clothes (*Advanced Functional Materials*, DOI: 10/f26hd5).

FINE ART IMAGES/HERITAGE IMAGES/GETTY IMAGES





World's cutest spiders

I THINK this is close to being a national scandal. Look at these beauties! Peacock spiders are stunning, with courtship displays to match anything in a David Attenborough documentary. So why aren't these animals more widely known in their home country of Australia? It's a mystery to the man who knows them best. "They are 3 to 5 millimetres in length and people simply don't expect such beauty and complexity from something that small, let alone something that is a spider," says Jürgen Otto.

Otto is a mite biologist at the Australian Department of Agriculture in Sydney, but peacock spiders have become his passion. He is puzzled as to why they weren't more widely documented until he started doing so in 2008. "These spiders aren't particularly rare in Australia - they occur from Melbourne all along the coast into northern Queensland. They can be observed close to all major population centres: Melbourne, Sydney, Brisbane, as well as Perth in the west."

He predicts that the spiders will soon become as iconic for Australian wildlife as kangaroos and koalas. "What is fascinating is how they change people's perception of spiders in general. Many people contact me and confess to being arachnophobes, but they tell me that watching my videos is helping them to overcome their fear of spiders," Otto says.

In large part thanks to Otto's efforts in documenting them (check out facebook.com/PeacockSpider), there are now some 58 known species of peacock spider. The two most recently discovered, from south-east Queensland, are *Maratus sceletus* (top middle) and *Maratus jactatus* (bottom right) which have been nicknamed Skeletorus and Sparklemuffin.

Otto loves them, and it's hard not to feel the same way. Watch the courtship display on one of Otto's many videos (see his YouTube channel, bit.ly/peacockspiderman), with the male tentatively signalling to the female and gingerly approaching her, and it's hard not to anthropomorphise. "It's the way they react to each other," says Otto, "It seems intelligent and similar to the way we react. You can see them excited, curious, fearful - emotions that we associate with ourselves." Rowan Hooper

Photographer

Jürgen Otto

Tweet victory?

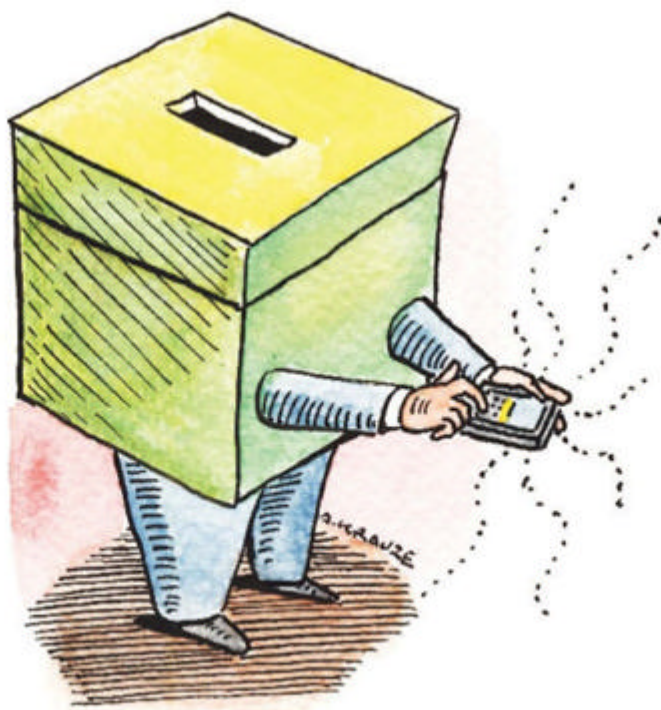
More and more politicians are using social networks to woo voters. What will be the impact of the digital campaign, wonders **Carl Miller**

BARACK OBAMA'S success in the 2008 US presidential race – dubbed the Facebook election – is credited with persuading politicians around the globe that they couldn't ignore the digital world. His re-election in 2012 was a powerful reminder. That campaign built a huge digital presence: 45 million Facebook likes, 23 million Twitter followers and 1 million downloads of its Facebook app. Crucially, Obama converted this into offline gains: 358,000 events were organised online, and \$690 million raised – over half of his total.

Similarly, in the 2014 Indian election, Narendra Modi became prime minister after enlisting 2.2 million volunteers via online tools, and engaging with hundreds of thousands to crowdsourcing his BJP party's manifesto.

How decisive social media was in those outcomes is an open question. In 2009, the Pirate Party in Germany dominated social media, but not the election result. During the Scottish independence referendum, the Yes campaign was ahead on social media throughout – and lost. Campaigners know online support matters, but the key is to convert it into volunteers, money and votes.

All eyes are now on the UK general election in May. As the campaign heats up, politicians are, often reluctantly, dragging themselves onto digital platforms, especially Twitter. A record 80 per cent of MPs standing for re-election have done so, sending a total of 10,000 tweets a week.



And the Conservatives reportedly spend more than £100,000 a month on Facebook.

There's no doubt that social media is changing politics. Social networks spell the end of message discipline. For decades, central party machines tightened their grip on what politicians said in public. This was a world of central planning that aimed to shape the news agenda, pager prompts to enforce a unified message and carefully briefed spokespeople.

All of that is being washed away in a wave of tweets. Backbench MPs are quietly dropping the party sound bites and slogans as they use Twitter to engage with constituents. They're even

dropping almost all mention of their own party leader. Of 15,000 recent tweets sent by Conservative MPs, just 69 mentioned David Cameron. Party hierarchies are trapped: they either accept this, or impose a draconian digital order on what MPs say and risk alienating the very group they seek to woo, those who value genuine online engagement.

Social media has also dissolved the barriers that used to bar entry into public life and political debate. An enormous digital

commons has been created and the UK public fires 300,000 tweets a week back at politicians – a barrage of insults, questions, support and jokes. Every major moment of a campaign, the gaffes, controversies, clashes and announcements, provoke enormous spasms of digital reaction. People flock to popular hashtags to boo, cheer, check facts or just to collectively experience political life.

As people step into this novel arena, they form different kinds of connections to politics. Parties now have more unique Twitter followers than they have formal party members. Likes, follows, retweets and favourites are new kinds of political identity, and a new way of expressing support. This connection is more casual and transient than formal membership. As these weaker ties become more dominant, party followership and loyalty become more volatile.

The digital campaign is also changing which voices dominate. Mainstream parties now have to compete with a much larger and more diverse group vying for digital attention, and in general they are not winning.

Comedian-turned-activist Russell Brand has three times as many Twitter followers as every British MP put together, and powerful protest voices have emerged on digital platforms, that – like Brand – dwarf the influence of politicians in this space. Groups, too, from left wing Occupy and Anonymous to the far right Britain First and English Defence League, have sprung up,

“Political parties now have more unique Twitter followers than they have formal members”

relying on social media to recruit, coordinate and keep members.

This trend could eventually change who enters formal politics. By 2020, individuals and groups will have emerged from the digital commons to contest the mainstream election – and they could win.

Recall the rise of Beppe Grillo, a grizzled, angry Italian comedian with no history in politics. He built millions of social media followers and the most popular blog in Italy. From that, he created the Five Star Movement, a furious, insurgent, anti-corruption groundswell. He refused to talk to mainstream media and had no big business funders. It didn't matter. Using Meetup – an online network facilitating offline gatherings – he built an army of volunteers, spoke to Italy through his blog and crowdfunded his campaign. In a year, he had come from nowhere to win 1 in 4 votes at the 2013 election.

The backdrop today is a crisis in politics for the mainstream, as anti-establishment parties spring up. When this trend and the rise of social media fully come together, the result will be a decisive transformation of the British political landscape. A chorus of charismatic, angry, insurgent and anti-incumbent voices will emerge to take on the mainstream parties, using digital platforms to organise, raise money and engage directly with the electorate. It is likely that those aged 18 to 24 will be more inclined to vote.

Make no mistake, underneath the trivial, ephemeral and the banal on social media, seismic changes are under way. Maybe the tremors won't be fully felt in 2015, but by 2020 the ground will be well and truly shaking. ■

Carl Miller is co-founder and research director of the Centre for the Analysis of Social Media at non-partisan UK think tank Demos. He writes about social media and the UK election for the *Sunday Times*, and is tracking millions of tweets sent during the campaign

ONE MINUTE INTERVIEW

All hail the Anthropocene

This era of humanity's big environmental impact needn't end badly, says **Christian Schwägerl**, if we can change our mindset



PROFILE

Christian Schwägerl is a journalist and biologist and was part of the Anthropocene Project at the House of World Cultures in Berlin, Germany. His latest book is *The Anthropocene: The human era and how it shapes our planet* (Synergetic Press)

What does the term Anthropocene – the proposed name for the geological era we live in – mean to you?

Many view the Anthropocene merely as the sum of all environmental problems. For me it's also the process of becoming aware of our collective responsibility in shaping the future Earth. Can we create a better or even positive geological record that will later tell the story of a planet that regenerated after exploitation?

A paper in *Nature* last week looked at arguments for an official Anthropocene start date (vol 519, p 171). What feels right to you?

The working group on the Anthropocene – part of the International Union of Geological Sciences – favours a date around 1950, when nuclear explosions and the start of modern consumerism started to have long-term effects on the biosphere.

How should we steer the Anthropocene?

The biggest challenge is to become less anthropocentric: we should stop optimising

the planet just for our short-term needs. Our economic system needs to start valuing healthy rainforest and the future inhabitants of Earth. An anthropocentric Anthropocene would be short.

How might we bring about such a change?

I'd like to see new cultural practices arise that express gratitude for what the planet does. Perhaps then in the future things will be totally reversed. Instead of one Earth Day per year, there will be 364. Once a year, we'll have an Anti-Earth Day and allow ourselves to destroy habitats, hunt rare animals, mess with the climate and put toxins in the water.

Do you think this year's climate summit can succeed where the others have failed?

Paris 2015 may be the last chance to agree on global carbon dioxide reductions before there are so many greenhouse gases in the air and the oceans that things get really nasty. To succeed, it would be better not to frame CO₂ reduction as "burden-sharing" any longer, but instead as an opportunity for a prosperous future and as a gigantic call for new R&D in energy, agriculture and materials.

You say we have to end "Holocene thinking". What does that mean?

Holocene thinking rests on the assumption that there is this big, inexhaustible alien space out there that we call the environment, from where we can get our raw materials and food and where we can dump waste. The environment will become the "invironment" in the Anthropocene – something we are deeply connected with.

What can people do to support this vision?

Don't get colonised by destructive industries. Enjoy breathing, eating, being in a forest or a green city space, enjoy helping others, paying attention to the colours and smells and creatures around you. In the Anthropocene we may one day cherish a square metre of wilderness as much as a painting of the same size by Van Gogh or Cézanne.

Interview by Rowan Hooper

A portrait of Simron Jit Singh, a man with dark hair tied back and a beard, looking slightly upwards and to the right. He is wearing a dark red t-shirt. The background is a plain, light-colored wall.

PROFILE

Simron Jit Singh is a social ecologist at the University of Waterloo in Ontario, Canada. His work on the Nicobar Islands before and after the 2004 Boxing Day tsunami is featured in a new documentary *Aftermath: The second flood*

Witness to a catastrophe

Rushing aid to disaster survivors can make their problems worse, warns **Simron Jit Singh**, who watched a traditional culture fall apart under the weight of good intentions

Photographed for New Scientist by Finn O'Hara

What first took you to the Nicobar Islands?

I was working with nomads in the Himalayas in 1998, when the Indian government called me, looking for someone who could document the traditional Nicobarese culture – somebody who could live in difficult conditions. The Nicobars had no real infrastructure or communications at the time.

Tell me about the islands and your first impressions.

It is a really stunning, beautiful place – and very isolated. The islands are part of the Andaman and Nicobar archipelago, about 1200 kilometres east of the Indian mainland in the Bay of Bengal. Around 12 or so of the Nicobars are inhabited and the population when I arrived was about 42,000. The last leg of my journey had to be by canoe.

How were you received by the Nicobarese?

I met the chief, Ayesha Majid, and she gave me permission to visit the villages. I slept in an old, broken building on Trinket island and I slowly started to get to know the people. Every year I spent about six months in the Central Nicobars, documenting everything. Eventually I became like part of the family. It went on like that for five years. Then the tsunami came.

Were you on the islands when it happened?

No, I was in India, en route to the Nicobars. When I got there three weeks later, the islands were unrecognisable. The entire coastline looked different because the islands had sunk a metre and a half due to the earthquake. The waves, some about 20 metres high, came many times and washed the islands from one end to the other. All the villages were gone, the surviving palm trees were half underwater, the sea was choked with debris. The official death toll was something like 4500, but most of us who worked there believe it was much higher.

What happened next?

By the time I got to the islands, at least 60 NGOs had arrived. The initial rescue had already happened. Then a lot of relief was brought in, and a lot of it was totally ridiculous, like blankets: it's a hot place and you give blankets? They brought in junk food, radios and gas stoves, but there were no liquefied-gas canisters on the islands at the time. The Nicobarese were mystified. The main thing they wanted was tools to rebuild their houses, and rice. The tools didn't come for a long time.

What was the Indian government doing?

They started by building tin shelters, but these were too hot inside and the Nicobarese refused to live in them. So each family was paid 3000 rupees [approximately \$70 at the time] to occupy the shelters, so the media could see them living in "civilised" homes. Meanwhile, 7000 modern homes were commissioned to be built, with imported materials, to accommodate nuclear families.

The problem is that Nicobarese culture is based around joint families of 40 or 50 people, typically in one extended home, with a head of the family who is in charge of property and resources. Building homes for nuclear families meant the joint family system was

"I became like part of the family. And then the tsunami came"

not respected. The entire aid blueprint was based on nuclear families – the concept of giving aid to giant families was unknown. The flood of cash multiplied the problem.

Where did the money come from?

The Indian government. Money was basically unknown before the tsunami: the island communities were self-sufficient. If they needed anything they couldn't produce themselves, they traded a coconut product called copra. But suddenly millions of dollars in compensation were being pumped in.

Compensation was paid to nuclear families. In the Central Nicobars, the women usually had more power, but according to Indian law it was men who were heads of the family, so they got the cheques. For years after the tsunami the aid flowed and the men had control over the money and resources.

The money attracted traders. They brought motorcycles, televisions, mobile phones, junk food, Coca Cola... goods that were unknown before. And they overcharged for everything. The money lasted until 2013.

You've called the situation a "complex disaster". What do you mean?

Natural disasters like earthquakes or tsunamis affect humans in material ways, such as loss of lives or property – and also in psychosocial ways, such as trauma. A complex disaster is a consequence of inappropriate interventions in the aftermath, which undermine and destroy the non-material attributes that normally allow any society to self-organise and stand on its own feet.

Would it be fair to say that the cultural fabric of the Nicobarese was ripped apart?

Absolutely. The whole family structure was broken into small pieces, and communities went from self-reliance to dependency. Where people used to work together, now there is competition and jealousy. When a society becomes unequal, it affects solidarity. And ill health has increased, especially diabetes, hypertension and stress. This is because the Nicobarese are not able to cope with paying for a modern life.

Another thing that broke down is the way the islanders relate to nature. In my early research, I discovered they had seasonal taboos about when to fish and hunt in certain areas. This is sustainability. But now, because the Nicobarese need cash to pay for things, the fishing is constant. There's a lot of pressure on resources.

How can we avoid complex disasters in future?

The short answer is responsible aid, where accountability is to the people you're trying to help, not to the donors. There's a saying: "If you can't count it, it doesn't count". It's easy to show your donors that you have built 7000 homes, distributed x tonnes of rice or installed 150 toilets. NGOs are in that trap: it's easy to show pictures of Nicobarese sitting on motorcycles and say they have been rehabilitated, but these organisations need to find new ways to measure their success.

And if you give to charity, you must become aware that giving \$50 and feeling good about it is not the end of your duty. You have to find out what's going on, take interest in the culture you are trying to support and demand culturally sensitive aid. One way would be through some kind of online donors' forum, where beneficiaries of aid can contribute to the discussion, to report how they perceive the aid projects in their area – to give them a voice. I call this the "democratisation of aid".

How is life in the Nicobars today?

It's not even one and a half years since the money ran out, but already 30 per cent of people are moving back towards a traditional lifestyle. I constantly hear of families moving back to their old locations. Eight nuclear families moved back to traditional housing on Trinket island just a month or so ago. Trinket was split in two by the earthquake, and has been virtually uninhabited since the evacuation of the tsunami survivors, so this is quite something. ■

Interview by Sean O'Neill

What might we discover about being human by giving a robot a sense of self? Tony Prescott is finding out

WHAT is the self? Rene Descartes encapsulated one idea of it in the 1600s when he wrote: “I think, therefore I am”. He saw his self as a constant, the essence of his being, on which his knowledge of everything else was built. Others have very different views. Writing a century later, David Hume argued that there was no “simple and continued” self, just the flow of experience. Hume’s proposal resonates with the Buddhist concept *anattā*, or non-self, which contends that the idea of an unchanging self is an illusion and also at the root of much of our unhappiness.

Today, a growing number of philosophers and psychologists hold that the self is an illusion. But even if the centuries-old idea of it as essential and unchanging is misleading, there is still much to explain, for example: how you distinguish your body from the rest of the world; why you experience the world from a specific perspective, typically somewhere in the middle of your head; how you remember yourself in the past or imagine yourself in the future; and how you are able to conceive of the world from another’s point of view. I believe that science is close to answering many of these questions.

A key insight is that the self should be considered not as an essence, but as a set of processes – a process being a virtual machine running inside a physical one, as when a program runs on a computer. Likewise, some patterns of brain activity constitute processes that generate the human self. This fits with Hume’s intuition that if you stop thinking, the self vanishes. For instance, when you fall asleep, “you”, the entity brought into being by a set of active brain processes, cease to exist. However, when you awake, those same processes pick up much where they left off, providing subjective continuity.

The idea that the self emerges from a set of processes has encouraged my colleagues and I to believe we can recreate it in a robot. By deconstructing it and then attempting to build it up again piece by piece, we are learning more about what selfhood is. This is an on-going collaboration with researchers in several European institutes, and admittedly

Me in the machine





DANIEL STOLLE

we still have a way to go. But I'm confident we can create an artificial self, or at least as much of one as would be wise. We believe our work will help resolve the mystery at the heart of self – that it feels compellingly real, yet, when examined closely, seems to dissolve away.

Meet iCub, the state-of-the-art humanoid robot in which we are creating this sense of self. This bot has vision, hearing, touch and a proprioceptive sense that allows it to coordinate its 53 joints. It can speak and interact with its world, and it improves its performance by learning. There are currently 30 such robots in research labs around the world. At Sheffield Robotics, our iCub has a control system modelled on the brain, so that it “thinks” in ways similar to you and me. For the past four years, we have been working to give this robot a sense of self.

We first had to consider exactly how we might deconstruct selfhood in order to build it in a machine. Philosophy, psychology and neuroscience give many insights into what constitutes the human self, and how to recognise and measure aspects of it in adults, infants and even animals. Our attempt begins with psychology, but can also be mapped on to a growing understanding of how the psychological self emerges from brain activity.

William James, a founder of modern psychology, suggested that the self can be divided into “I” and “me” – the former comprising the experience of being a self, the latter the set of ideas you have about your self.

“WE CAN CREATE AN ARTIFICIAL SELF, OR AS MUCH OF ONE AS IS WISE”

In the 1990s, psychologist Ulric Neisser, a pioneer of modern cognitive psychology, went further. He identified five key aspects of self: the ecological or physically situated self, the interpersonal self, the temporally extended self, the conceptual self and the private self (see “Aspects of self”, page 38). Neisser's analysis is not the final word, but it is grounded in an understanding of human cognitive development, whereas classical philosophical views such as those of Hume and Descartes were not. It has also provided useful clues about what might be required to build up an artificial self, process-by-process.

How have we gone about creating these processes for our robot? We use an approach called neurorobotics, which means we incorporate knowledge about how real brains work into our programming. So our iCub's ➤

ASPECTS OF SELF

Psychologist Ulric Neisser's multifaceted description of the self provides useful targets for a robot to emulate

ECOLOGICAL SELF

Having a point of view; distinguishing yourself from others; having a feeling of body ownership

INTERPERSONAL SELF

Self-recognition (e.g. in a mirror); seeing others as agents like you; having empathy for others

TEMPORALLY EXTENDED SELF

Having awareness of your personal past and future

CONCEPTUAL SELF

Having an idea of who you are; having a life story, personal goals, motivations and values

PRIVATE SELF

Having a stream of consciousness; knowing you have an inner life

control system is designed to emulate key processes found in the mammalian brain. The interactions between these processes are governed by an architecture called distributed adaptive control, developed by my colleague Paul Verschure at the Catalan Institution for Research and Advanced Studies in Barcelona, Spain. This system is modelled on the cognitive architecture of the brain.

Motor babbling

Now, say we want to start building a process that emulates the human ecological self. Key to this is an awareness of one's body and how it interacts with the world. For iCub to achieve this, it needs an internal "body schema" – a process that maintains a model of its physical parts and its current body pose. Rather than programming the body schema directly, as other roboticists might do, we have given iCub the capacity to work it out. It learns by generating small, random movements and observing the consequences these have. Human babies show a similar kind of exploratory behaviour – termed motor babbling – in the womb and in early infancy, suggesting that people learn about their bodies in much the same way.

Using this approach, Giorgio Metta and colleagues at the Italian Institute of Technology in Genoa, Italy, are training our iCub to distinguish self from other, a fundamental aspect of the ecological self. The motor babbling program also allows the robot to learn how to achieve a specific target pose. Combining this body model with knowledge of objects and surfaces nearby enables iCub to move around without colliding with things.

Then there's the temporally extended self. Insights about this can be found in the case of a man we will call N.N., who lost the ability to form long-term memories after an accident in the 1980s. The damage to his brain also left him completely without foresight. He described trying to imagine his future as "like swimming in the middle of a lake. There is nothing there to hold you up or do anything with." In losing his past, N.N. had also lost his future. His ecological self remained intact, but it had become marooned in the present.

This concept of time also poses a problem for our robot. Although we can channel all its sensory input into a hard drive, iCub must also be able to decide how best to use the information to make sense of the present. Peter Dominey and his group at the French Institute of Health and Medical Research in Lyon, have addressed this problem. They have encoded iCub's interactions with objects and

people in a way that allows it to more clearly see their relevance to present situations. However, this model uses standard computing techniques, so we are working with them to create a neurobotic version. It will directly emulate processing in brain areas, such as the hippocampus, that are known to play a role in creating human autobiographical memory.

Recent brain imaging studies have confirmed what we learned from N.N.'s experience: that the same brain systems underlie our ability to recall past events as well as imagine what the future might bring. Our hope is that a model of the temporal self will provide iCub with contextual information from the past that will help it to better understand its current experience. This, in turn, should improve its ability to predict what could happen next.

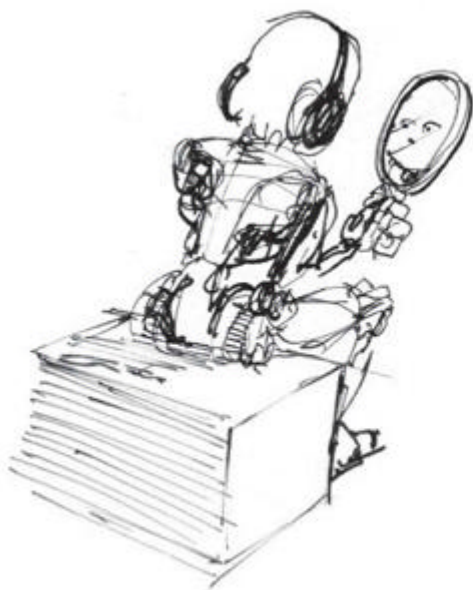
Thinking about self as a set of processes, it becomes clear that some of these are connected. For example, a key aspect of the interpersonal self is empathy, which derives from a general ability to imagine oneself in another's shoes. One way humans might do this is to internally simulate what they perceive to be the another's situation, using the model that underlies their own ecological self. So the interpersonal self could grow out of the ecological self. But what more is needed? We consider an important building block to be the capacity to learn by imitation.

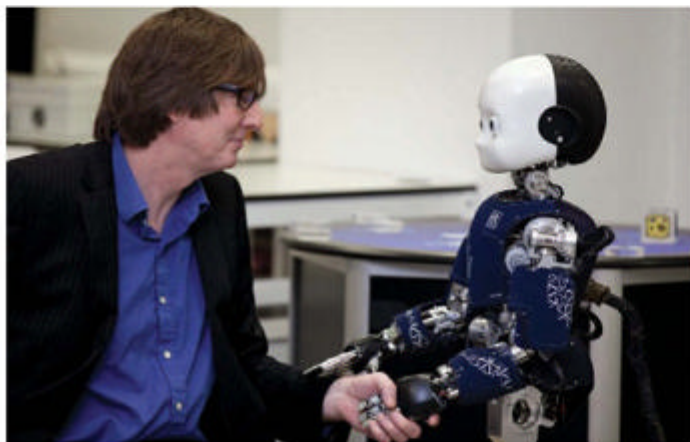
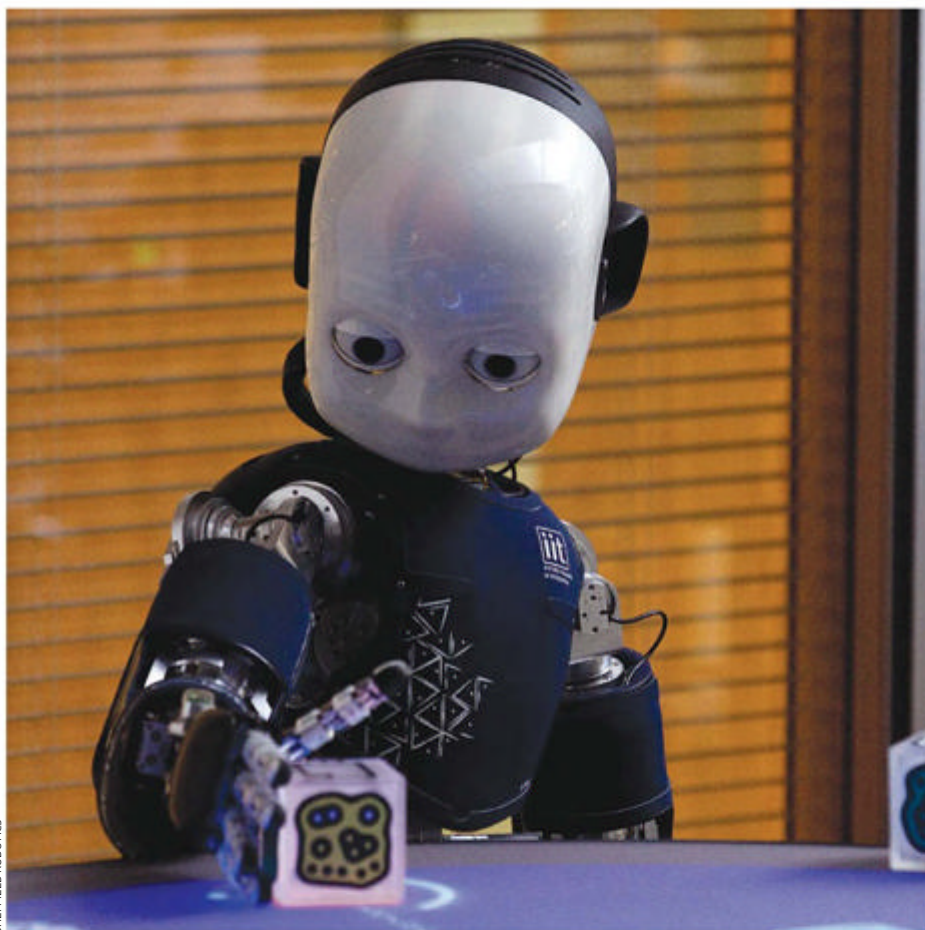
Your ability to interpret another person's actions using your own body schema is partly down to mirror neurons – cells in your brain that fire when you perform a given movement and when you see someone else perform it. Using this insight, Yiannis Demiris at Imperial College London has extended iCub's motor

"SOMETIMES ICUB GIVES THE SURPRISING IMPRESSION THAT 'SOMEONE IS HOME'"

babbling program into an imitation learning system. As a result, iCub can rapidly acquire new hand gestures, and learn sequences of actions involved in playing games or solving puzzles, simply by watching people perform these tasks. The system will have to be extended further to achieve empathy, so that iCub recognises and mirrors a person's emotional state as well as their movement.

There is still plenty to do. Our models of the ecological, interpersonal and temporal selves are undoubtedly crude in comparison to what goes on in human brains. And we have yet to tackle the conceptual and private selves that





In just four years, iCub has been imbued with key aspects of the ecological, temporal and interpersonal self

would provide iCub with knowledge of what – or who – it is, and an awareness that it has an internal world not shared by others.

When we meet the challenge of making iCub's self processes more realistic, there may be some aspects of the human version that we will not want to emulate. For example, the robot's motivations and goals are essentially those we design in, and it might be wise to leave things that way, rather than allow them to evolve as they do in people.

Something else holding us back is iCub's limited understanding of language. Although our robot can recognise speech, this is not the

same as understanding meaning – that requires relating words to action and objects. Our colleagues in Lyon are working on a neurobotic solution to this problem but, for the moment, iCub is only capable of two-way conversations on a few topics, such as the game it is currently playing with you.

That said, we can see the practical potential of robots of this kind. An ecological self makes our iCub safer to be around. The temporally extended self allows it to remember the past and anticipate the future. The interpersonal self means it can conceive of, and anticipate, human needs and actions. Such a robot could

work alongside people in fields from manufacturing and search-and-rescue to helping care for people with disabilities.

You might argue that our models have missed a crucial element: the “I” at the centre of James' notion of self – what we also call consciousness. But one possibility is that this arises when the other aspects of self are brought together. In other words, it may be an emergent property of a suitably configured set of self processes, rather than a distinct thing in itself. Returning to the Buddhist idea of the self as an illusion, when you strip away the different component processes, perhaps there will be nothing left.

But is it a person?

Our idea of the self is intimately tied up with our notion of what it means to be a person. Is it conceivable, then, that one day we might attribute personhood to a robot with an artificial sense of self? In the 17th century, philosopher John Locke defined a person as an entity with reason and language, possessing mental states such as beliefs, desires and intentions, capable of relationships and morally responsible for its actions. Modern philosopher Daniel Dennett at Tufts University in Boston largely agrees, but with an important addition. A person, he says, is someone who is treated as a person by others. So we grant personhood to one another.

Note that neither Locke nor Dennett specify that a person is made of biological stuff. Even so, at this stage, our iCub falls short of the criteria required. It can reason, use language, have beliefs and intentions, and enter into relationships of a kind. We might even be inclined to judge it for the appropriateness of its actions. However, it does not yet have the full set of processes associated with a human self, so we cannot be sure that its mental states are anything like ours. Neither is it a moral being – not as we commonly think of them – because it does not base its choices on values.

Be that as it may, our everyday attribution of personhood is grounded more in direct impressions than a philosophical checklist. As Dennett says, personhood is partly in the eyes of the beholder. And, when interacting with iCub, it can feel natural to behave towards this robot as though we are taking the first steps in creating a new kind of person. Sometimes it even leaves me with the surprising feeling that “someone is home”. ■

Tony Prescott is professor of cognitive neuroscience at the University of Sheffield, UK, and director of Sheffield Robotics

DURING the Middle Ages, the Vikings set sail in longships to raid settlements and plunder riches, but how did they find their way? They had no magnetic compasses, and the sun and stars would have been obscured on cloudy days and during the long twilight of the northern summer.

According to one suggestion, the answer lies with a special crystal or “sunstone”. This, some physicists argue, allowed these seafarers to navigate the north Atlantic by revealing the position of the sun when it was hidden behind clouds, and even after sunset. Yet many archaeologists and historians have serious doubts, pointing to a lack of solid evidence.

It is a debate that doesn’t just bear on Viking navigation. It also goes to the heart of what experimental science can and can’t contribute to our understanding of the past. But who is right? And what does the archaeological and historical evidence reveal?

The sunstone hypothesis stems largely from a 13th-century manuscript, *St Olaf’s*

Saga, in which the hero Sigurd tells King Olaf II Haraldsson of Norway where the sun is on a cloudy day. Olaf checks Sigurd’s claim using a *sólarsteinn* or sunstone: *Olaf grabbed a sunstone, looked at the sky and saw from where the light came, from which he guessed the position of the invisible Sun.* Another tale called *Hrafns Saga* fleshes out the details: *The King looked about and saw no blue sky... then the King took the sunstone and held it up, and then he saw where the Sun beamed from the stone.* But what is a *sólarsteinn*?

Rotate until brightest

In 1967 Danish archaeologist Thorkild Ramskou suggested that the mysterious object could be a chunk of a “birefringent” mineral such as cordierite. As light passes through this type of crystal, rays of different polarisations are refracted by varying degrees. Used correctly, the crystal can work as a natural Polaroid filter, transmitting or blocking

polarised light depending on its orientation.

With such a crystal, you can pinpoint the sun in the sky. As sunlight is scattered by tiny particles in the atmosphere, it becomes polarised in a circular pattern centred on the sun. Ramskou suggested you could use this polarised light to find the sun, even when it is hidden behind clouds. The idea is to hold up the cordierite crystal to the sky and rotate it until the light passing through it appears brightest. The crystal’s orientation then points towards the position of the sun (see diagram). That knowledge, together with the rough time of day, tells you where north lies. Birefringent minerals such as cordierite and calcite are abundant in Scandinavia. So maybe longships carried these crystals to help the navigators?

In 1994 the idea was finally put to the test – and summarily dismissed – in a study by astronomer Curt Roslund and ophthalmologist Claes Beckman of the University of Gothenburg in Sweden. They found that the small differences in brightness

A VIKING SAGA

Did Norse seafarers really find their way across stormy oceans with the aid of a delicate crystal? Philip Ball unravels a tangled tale

produced when rotating a birefringent crystal in diffuse sunlight are simply too weak for the eye to detect. Besides, they argued, humans are very good at judging the location of the sun behind clouds unaided. The sunstone idea “has no scientific basis”, they reported.

This was the opening salvo in what became a long-running debate. In 2005, researchers led by Gábor Horváth at the Eötvös Loránd University in Budapest, Hungary, fought back. Their tests on volunteers suggested that we can't rely on our eyes to locate the sun behind clouds. Subsequent calculations, along with measurements made by Horváth across Europe and in the Arctic, also contradicted Roslund and Beckman: they showed that picking out the patterns of polarised sunlight with sunstones, even under foggy or cloudy skies, is perfectly feasible.

At the University of Rennes in France, optical physicist Guy Ropars had been following these arguments. Although he agreed with Roslund and Beckman's concerns, he realised there was a way to address them.

Our eyes may not be good at recognising subtle changes in brightness against a light background, but they are much better at comparing lights to spot small differences in intensity. Ropars decided to make use of this.

Shine a beam of light through a birefringent crystal and it splits in two. One beam travels straight through, while the other is offset by a small amount. The relative brightness of these beams depends on the polarisation of the light and the crystal's orientation.

Practical tool

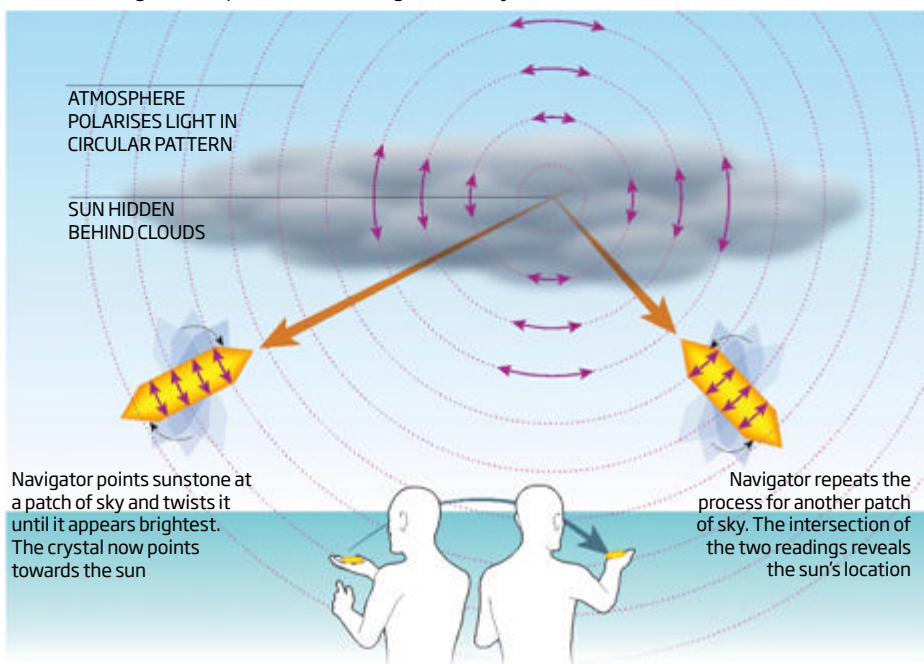
Ropars and his colleagues used a screen containing a narrow hole, through which light from the sky could reach a birefringent crystal. Seen through the crystal, the hole appeared as a pair of bright spots corresponding to the two beams. Then they rotated the crystal until the spots were of equal intensity. At this point, the crystal's orientation indicated the sun's position. Ropars says the precision in measuring this with a calcite crystal can be 100 times better than in Ramskou's scheme.

Tests showed that this system can locate the direction of the sun to within 1 degree, even when it is below the horizon. Ropars says the method works even up to the moment at which the first stars appear.

The team even turned this into a practical navigation instrument – the Viking sunstone compass. Light falls through a hole in the top of a wooden cylinder on to a calcite crystal, forming two bright spots on a screen, which can be viewed through a hole in the side of the cylinder. The crystal itself is on a rotating mount, turned by a handle on the lid. “You rotate the crystal to equalise the intensities of the beams,” says Ropars. A pointer on the lid then indicates the orientation of the crystal

Crystal compass

The Vikings could have used polarising crystals called “sunstones” to navigate when the sun was hidden by clouds. Knowing the sun's position and the rough time of day will let them work out where north lies



and the direction of the sun, so you can work out where north lies. Ropars and his colleagues hope to commercialise the compass.

So experiments show that the Vikings could have navigated with sunstones. “But this is a different question to ‘did the Vikings use sunstones?’ which is what most historians are interested in,” says Alun Salt from UNESCO's Astronomy and World Heritage Initiative. The problem is that scientists dabbling in archaeology often try to answer questions that no historians are asking, he says. What is needed is solid archaeological evidence.

So far, there's not much to go on. Over the years, a number of Viking objects thought to play a role in navigation have turned up, including wooden sundials. But no sunstones.

Then in October 2002, archaeologists discovered a matchbox-sized calcite crystal in the remains of a shipwreck near the island of Alderney in the English Channel. It was found close to a set of navigational dividers, and tests

Could this calcite block have been part of a Tudor ship's guidance system?



suggest it could have been used to navigate. However, the ship was Tudor, not Viking.

Experts suggest this crystal was used to judge the sun's position as it rose and set, to help correct for compass errors caused by the vessel's iron cannons. There is no evidence it was used to guide the ship directly.

Yet the Alderney find does prove that 16th-century sailors possessed such crystals, and lends hope that similar ones could survive in the remains of older vessels. And there is other tantalising evidence besides the Norse sagas to suggest Viking sunstones are not fiction. Archaeologists have found fragments of calcite crystals in a Viking settlement in Iceland. Sunstones are also described in other medieval documents – there are references in 14th- and 15th-century inventory lists from Icelandic monasteries, where the crystals may have been used as timekeeping tools for prayer sessions. Of course, monks weren't sailors. “So we're now looking for mentions of sunstones in navy reports of the 15th and 16th centuries,” says Ropars.

Unless definitive evidence turns up, sunstone compasses will remain a testament to human ingenuity rather than a historical reality. If sailors ever used such tools to cross the Atlantic in a reconstructed Viking ship, it would be impressive but prove nothing historically – although it would show how speculation about what might have been can stimulate invention. And for now, maybe that's enough. ■

Philip Ball is a freelance writer based in London



A world without chickens

We often take this humble bird for granted, but could humanity survive without it?

Andrew Lawler
investigates

IF THE world's cats and dogs disappeared overnight, millions of people would mourn their furry friends. If beef cattle suddenly ceased to exist, it would create economic crises in America, Argentina and Australia. But what if all of Earth's 22 billion chickens succumbed to a scourge like bird flu? How would humanity cope?

It's a thought experiment whose answers show just how much human civilisation has come to rely on a single species. Without chickens, we would face "a starving world", says Olivier Hanotte, a molecular biologist at the University of Nottingham, UK, who has studied the spread of the chicken around the globe. Close to one-third of the world's meat

supply and nearly all of its eggs would vanish. Pandemics and riots could ensue, unleashing a crisis of enormous proportions. This might seem far-fetched given how unremarkable the bird appears. But as a ubiquitous food source and more, it has pecked and scratched its way into almost every corner of human existence.

The story of the chicken-human bond is an ancient one. Some 3000 years ago, Polynesians took chickens with them on their expeditions to settle Pacific islands, using their bones to make sewing needles, tattooing implements and even musical instruments. Ancient Greeks considered the bird sacred to their god of healing, and believed its parts could cure illnesses ranging from burns to bed-wetting. Roman generals kept a flock of chickens on hand before battles for military advice. If the sacred birds ate heartily before the conflict began, then the generals could expect victory; if they turned up their beaks, then best to retreat. And cockfighting is probably the oldest spectator sport after boxing.

Today, of course, the chicken is chiefly a source of food. In that role, it has become staggeringly abundant, outnumbering all the pigs and cows on the planet combined. Add in



dogs and cats, and there would still be more chickens. For every person, three chickens are alive and clucking today. Humans gobble down almost 100 million tonnes of chicken meat and over 1 trillion eggs annually. On a single day this year, Super Bowl Sunday, Americans ate an estimated 1.25 billion chicken wings.

Yet this popularity is surprisingly new. As recently as 1950, Americans ate twice as much red meat as chicken. Today that situation is reversed. The chicken's rise began after the second world war, when US poultry breeders developed a bird for mass production that grew bigger breast muscles, required less feed, took far less time to mature, and produced tender meat that could be carved almost like a steak.

This highly engineered animal now powers huge poultry industries throughout the world. Though people in Asia still eat fewer chickens than North Americans, they are catching up: chicken is poised to surpass pork – the traditional Chinese favourite – as the world's most popular meat by 2020.

What would we do without it? Recent events suggest we could be in big trouble. Mexicans eat more eggs than anyone else – about 330

each year, on average – and when egg prices shot up in Mexico City in 2012 following the culling of millions of sick birds, demonstrators took to the streets in what was dubbed “The Great Egg Crisis”. During the 2011 uprising in

More than
22 billion
chickens
live on the
planet – **three**
for every
human

Egypt, angry protesters rallied to the cry: “They are eating pigeons and chicken, but we eat beans every day!” When poultry prices tripled in Iran recently, the nation's police chief warned television producers not to broadcast images of people eating chicken to

avoid inciting violence. Across the Persian Gulf in Saudi Arabia, chicken feed is subsidised to keep meat prices low and a potentially restive population quiet.

Why has the chicken – rather than, say, the duck or yak – emerged as the single most important animal species for humanity? The answer lies partially in its remarkable adaptability.

Charles Darwin, who spent a good deal of time and money studying the bird, was one of the first to realise this. He collected chickens from all over the world, many of which he bequeathed to the Natural History Museum in London. Some are skins that were prepared using a particular technique. “You remove their innards, pop out the brains and eyes, and sew them back up,” curator Joanne Cooper explains cheerfully when I visited the collection.

Through typically patient study, Darwin deduced that all varieties of domestic chicken descended from the red jungle fowl, a shy and elusive pheasant that lives across south Asia and parts of China, and is adapted to a variety of habitats. His conclusions were confirmed in 2004, when the bird's genome was sequenced.

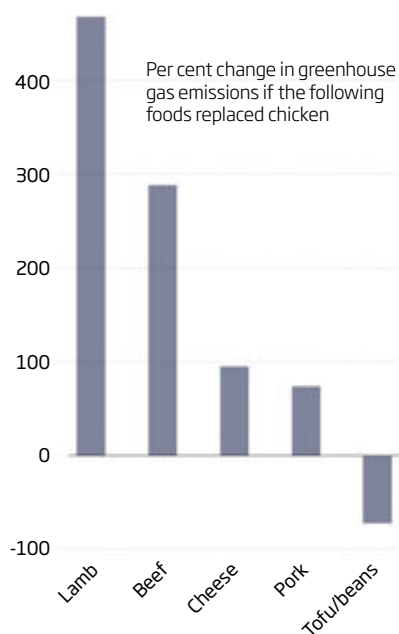
The red jungle fowl, which was domesticated at least 4000 years ago, bequeathed the chicken a genome forged by a wide range of environments, from Himalayan foothills to Sumatran jungles. Along the way, the domestic chicken may have also picked up genes from other jungle fowl subspecies, including the Indian grey jungle fowl. “What is remarkable about the chicken is its genetic diversity,” says Hanotte. “It’s probably the most genetically diverse species of livestock, with the possible exception of pigs.” This has not only helped the village chicken thrive on every continent except Antarctica, but has also allowed humans to breed what American ornithologist William Beebe called “beautiful, bizarre, or monstrous races” of chickens, from fluffy silkies to leggy langshans.

The rise of the chicken is not necessarily a bad thing, in fact, the bird is something of an environmental hero. To understand its impressive efficiency, let’s imagine the impact of replacing chicken with meat from other livestock animals.

Beef, which makes up about a quarter of the meat eaten in the US, would be the most disastrous replacement. Kilogram for kilogram, we would have to find over 1000 per cent more land for beef than is used to produce chicken,

Henhouse to greenhouse

Chickens produce protein quite efficiently. The same amount of food from other sources would generally raise greenhouse gas emissions, though tofu and beans are an exception



SOURCE: FAO ENVIRONMENTAL WORKING GROUP, CLEANMETRICS

an area larger than China and India combined.

Cows convert food into meat far less efficiently than chickens, so even if we turned entirely to intensively raised grain-fed cattle we’d need to provide them with eight times as much feed to get the same amount of meat. Given that growing food for livestock already takes up around a third of the arable land on Earth, there might not be room.

What about pigs? We would need to at least double the number from 1 to more than 2 billion to take care of the meat shortfall, and more of the planet would need to become farmland since pigs require almost 14 per cent more feed than chickens to produce a kilogram of meat.

If we’re talking about the environment, there’s also the matter of gas. Unlike chickens, cows and sheep ferment their meals in a bacteria-rich stomach called the rumen, producing large amounts of the potent greenhouse gas methane in the process. Beef is responsible for almost four times the amount of greenhouse gas (including carbon dioxide) per kilogram of meat as chicken, while lamb produces over five times as much. Switching to cheese as a source of protein would almost double greenhouse gas emissions, while turning to pork would increase them by 75 per cent. Satisfying the world’s insatiable demand for meat without chickens would slam down the gas pedal on global warming.

What about other birds? Ducks and turkeys might seem like sensible replacements, but they have several drawbacks. You can’t put turkeys and geese into small enclosures, and ducks need water. “You don’t find ducks in semi-desert subsisting on vermin,” says Hanotte. “Ducks are adaptable, but they’re not as adaptable as chickens.” Turkeys are not as efficient egg producers, and neither species produces as much meat as chickens do on the same feed. “Ducks and turkeys have their niche, but they are not going to be competitors,” says Hanotte. He thinks that, in terms of protein, insects rather than ducks would be the most likely replacement.

Avian lifesavers

The nascent insect protein market might well expand, but in the meantime demand for seafood would surge, potentially pushing many of the world’s fisheries – which currently produce some 80 million tonnes per year – to collapse. Aquaculture

Hens don’t need males to stimulate egg laying – only exposure to about **14 hours** of light



would ramp up, but it would take time to increase production (now about 60 million tonnes a year) to make up for all that chicken.

Some countries might be able to keep their populations in meat – the US, for example, could halt all beef and pork exports and return to something resembling its pre-1950 meat-eating habits. And for those Westerners willing to explore plant-based meat substitutes, foods such as textured wheat protein (already used in “chicken-less nuggets”) would likely become more widespread. Such a switch could make a difference to the environment: if we all swapped chicken for beans, for example, greenhouse gas emissions would be much lower. Chicken is responsible for 6.9 kg of greenhouse gases per kg of meat, compared with 2 kg for bean protein (see diagram, left).

Other places might not fare so well. In parts of Africa and Asia, where chicken is common street food and even the poorest can keep a fowl or two in their backyard, the bird’s demise would lead to skyrocketing malnutrition rates. Chicken meat and eggs are particularly rich in the essential amino acids lysine and threonine,



The blue partridge brahma showcases the chicken's adaptability

that if you had H5N1, that it could wipe out every chicken on the planet," says Bucher.

Swiss pharmaceutical company Novartis has developed an alternative called Flucelvax grown in the kidney cell line of a cocker spaniel, which was approved in Europe in 2007 (under the name Optaflu), and in the US in 2012. The drug is only approved for people aged 18 and older, however, and it would take time to scale up to meet worldwide demand. "Things could change, but we're certainly not there yet," says Bucher.

If the chicken were to disappear, one flu season could kill 50,000 people in the US alone, Bucher estimates. And if a new swine flu or similar pandemic broke out, humanity would have little defence against its ravages.

Adieu, souffle

Of course, amid the riots and malnutrition and illness, our sweet tooth would suffer too. The disappearance of eggs would change pastry as we know it, says Ludwig Hely, executive pastry chef at The Savoy hotel in London. "It would be terrible. It is by far the hardest ingredient to replace," he says. "Flour is easy, but if we didn't have eggs, we would lose the structure and lightness." Eggs from ducks or even quails might provide a substitute, but their relative rarity would make pastry an expensive treat. Meanwhile, egg replacements would become more common, with ingredients like silken tofu, baking powder and flaxseed meal being used to bind and leaven dough. Such ingenuity will be familiar to those who experienced rationing during the second world war. Some are already working on a modern-day version of this resourcefulness: Jason Sellers, head chef at Plant, one of the US's top vegan restaurants, says that he has figured out how to make an eggless meringue. Yet even he admits that sometimes eggs are impossible to

which our bodies cannot manufacture. "It is impossible for the world to exist as it does today without the animal protein via chicken eggs and meat," says Jianlin Han, a biologist at Beijing's Institute of Animal Science in China.

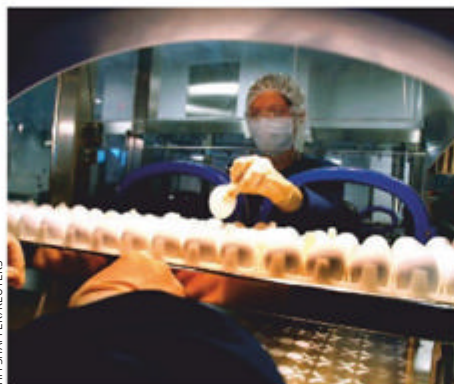
So much for nutrition. The chicken plays another, more hidden role in society: its eggs are crucial for making flu vaccine. To produce the world's 400 million annual doses, cultured flu strains are injected into fertilised eggs, a nutrient-rich and otherwise sterile environment in which the virus quickly multiplies. The virus-laden fluid is harvested, and the virus killed or weakened, with one egg equalling approximately one vaccine.

"It's just amazing how well influenza virus grows in eggs," says Doris Bucher, a microbiologist whose lab at New York Medical College is one of just three in the world that grow flu strains for the annual vaccine. "It's the cheapest way to produce it."

The US in particular has funded a hunt for alternatives to the egg-based vaccine, in part because of fears over what might happen if chickens disappeared. "There was a concern

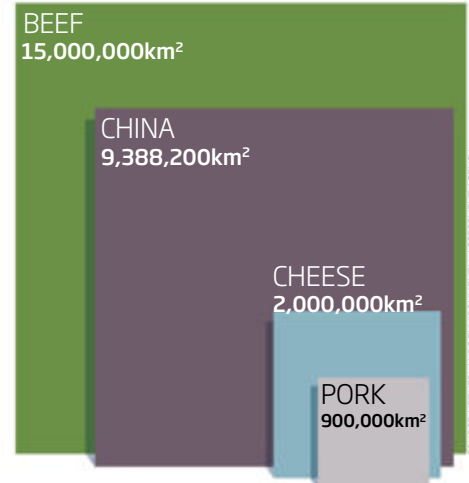
JIM RICHARDSON/NATIONAL GEOGRAPHIC STOCK

TIM SHAFFER/REUTERS



Land Grab

If other animal products replaced chicken as a source of food, a lot more land would be needed



replace. "There are some things that you just can't do without eggs, such as soufflé," he says.

The consequences of a chicken exodus would not be all bad. Fewer people would contract salmonella. The bacterium, which is most often found on raw chicken, kills about 115,000 people worldwide every year, and sickens tens of millions.

Anyone concerned about animal welfare would surely cheer the fact that billions of chickens, which under the laws of most governments have no protection and lead short and brutal lives, would finally be freed from servitude, even at the cost of extinction. Anthropologist Steve Striffler, whose book *Chicken* explores the history of the bird's industrialisation, says that while the chicken is a crucial source of protein to the world's rural poor, its disappearance in developed economies might not be a bad thing. "About 75 per cent of chickens are produced industrially in the First World," he says. "They are raised under extremely bad circumstances and essentially have no lives. And all this for food that is often produced in ways that are bad for workers, consumers, and the environment."

How likely is Chicken Armageddon? The bird is increasingly concentrated by the million in enormous farms, and therefore is more susceptible to the spread of disease than most village birds. Avian flu a decade ago resulted in the culling of over 100 million birds across Asia, and has reared its head again this year. Yet the chicken is nothing if not a survivor. It has spent the last several thousand years alongside humans. And every year, it becomes more inextricably bound up with our well-being. The sky might not fall, but a chicken-less planet would be nothing to crow about. ■

Andrew Lawler's book *Why Did the Chicken Cross the World?* will be published in the UK on 7 May

Naming and shaming

Shame is a potent weapon— handle with care, says **Bob Holmes**

Is Shame Necessary? New uses for an old tool by Jennifer Jacquet, Pantheon Books, \$24.00/£14.39
So You've Been Publicly Shamed by Jon Ronson, Picador Press, £14.99

LET'S put shame to work for a good cause. That's the provocative assertion of Jennifer Jacquet, a conservationist at New York University. In *Is Shame Necessary?* she argues that we need to rely more on shame, and less on guilt, as a way of putting pressure on people and institutions to act in environmentally responsible ways. While guilt is a private emotion, a failure to live up to one's own standards, shame occurs when a transgressor is held up to public disapproval. And that, Jacquet says, makes all the difference.

For one thing, institutions such as governments and corporations lack the capacity to feel guilt but they can be shamed into changing their behaviour. The private nature of guilt also means that people can find their own ways of salving their consciences, often in trivial ways. "Consumers are swept up in using reusable bags and mugs and turning off the lights," she writes. "This is like taking vitamin C after fracturing your skull in a car accident. It is not wrong; it is just so far from what is needed to actually fix things."

Shaming, by contrast, gives citizens a way to shine a light on the worst offenders – the bad apples that cause harm out of all proportion to their numbers. Think of the US and China and their carbon emissions, or the American coal-mining companies that level whole mountains in Appalachia. The bad publicity



that results can sometimes change policies, much as the campaign for dolphin-safe tuna did in the late 1980s.

Jacquet systematically explores the nature of shaming and some of the psychological evidence that shows why it works. In doing so,

"We are defining the boundaries of normality by tearing apart the people outside of it"

she makes a strong case for the value of shaming for shaping and enforcing social norms.

She is less successful when she goes on to lay out a set of best practices, which she calls "The seven habits of highly effective shaming". These are likely to strike

Exposed: a spotlight on corporate offenders can change policies

most readers as a bit obvious. We should expose the misdeeds to people who care and who the transgressor cares about – customers, for example. Then pick a big misdeed not a small one, and choose a spokesperson that the audience trusts to do the shaming. Do we really need "best practices" that suggest we focus our efforts where pay-offs are likely to be greatest or did we know that already?

We can forgive Jacquet this lack of sophistication because of the relative newness of her topic – her book is the first I know of that addresses shaming in such detail. As such, it makes a valuable

contribution by drawing our attention to the potential value of this strategy whenever we seek to change how institutions behave.

Shaming may be less desirable when directed at individuals, though, because the collateral damage is so great. This is the central point of *So you've been publicly shamed*. Here, Jon Ronson, a well-known writer (think *The Psychopath Test*) and broadcaster, explores in gripping detail several notorious examples of people who have been publicly shamed for misdeeds great and small. In several cases, Ronson was the first journalist to whom the "shamed victims" spoke.

For example, he talks to Justine Sacco, a woman who tweeted a clumsy joke to her 170 followers that later went viral. Sacco, by Ronson's account a basically well-intentioned person, soon found herself hounded as an international pariah, fired from her job and forever branded as the worst sort of racist (just Google her name). For anyone with even the tiniest public presence, examples like these are the stuff of nightmares.

And these days, that means almost everyone. Ronson's book is a powerful warning against mob rule on the internet. "We are defining the boundaries of normality by tearing apart the people outside of it," he writes. Readers are likely to come away sharing Ronson's conviction that this is not something we should be proud of. His book and Jacquet's stake out two corners of a conversational space that it's high time society entered. ■

Bob Holmes is a consultant for *New Scientist*

Quest for a great one-liner

Your winning words will inspire SCI-FI-LONDON's 48 Hour Film Challenge

CULTURELAB has teamed up with SCI-FI-LONDON to offer readers the chance to win tickets to the 2015 SCI-FI-LONDON Film Festival.

The festival runs from 28 May to 6 June at venues across the UK capital, and showcases some of the best and most original films in science fiction, including a selection of UK and world premieres.

It will include features, documentaries, short films, animation and film-making events, plus a host of industry workshops and networking sessions, but the festival is probably best known for its 48 Hour Film Challenge.

Over the last five years, this contest has seen more than 1000 films completed, some of which have been screened at other film festivals, broadcast on TV or, on a couple of occasions, even led to feature film deals. The competition's first winner,

Gareth Edwards, went on to direct *Monsters* (2010) and *Godzilla* (2014), and is currently working on a spin-off of the *Star Wars* franchise.

This year's 48 Hour Film Challenge takes place from 11 to 13 April, and will be judged by a jury that includes the writer Neil Gaiman, Adam Rutherford from

BBC Radio 4's *Inside Science* and film composer and musician Simon Boswell. Participants have to create a sci-fi short in only 48 hours, based on a set title and prop list, and all submissions must include a specific line of dialogue. This is where you come in.

Write a line of dialogue that

creates an interesting premise for a science-fiction film, and submit it via the form at bit.ly/NSmovieline. Make it something intriguing to do with science, and remember that the film-makers are constrained by time and resources. Entries should be no longer than 20 words.

We'll pick the snappiest, most originally expressed ideas we receive. The judges from *New Scientist* and SCI-FI-LONDON will then select one winner who will receive a pair of tickets and party invites to the 2015 SCI-FI-LONDON Film Festival, plus an ev ATC hard disc by G-Technology. This rugged disc is built to store up to 1 terabyte of data and to cope with the rigours of location filming.

Nine runners-up will also be selected, each winning a pair of festival tickets.

The closing date for entries is 2359 GMT on Friday, 3 April 2015. Full terms and conditions are at bit.ly/NSmovieline. You can find out more about the festival at sci-fi-london.com. ■



Godzilla's director Gareth Edwards won the first 48 Hour Challenge

Theatre's dark arts

Flatland, Dilston Grove, London
Simon Parkin

THERE is a disproportionate focus on the visual in public art exhibits. This, anyway, is the view of Maria Oshodi, artistic director at Extant, a professional theatre company of visually impaired artists. And this is why, for a chilly week in March, a cavernous hall in south-east London's Dilston Grove hosted *Flatland* – a drama delivered in total darkness.

Flatland is still in its proof-of-concept phase – the final production won't launch till 2018. It gets its inspiration from an 1884 satirical novella written by the English schoolmaster Edwin Abbott. Abbott tells the story of a two-dimensional world populated by two-dimensional characters. In Extant's version, an exile from *Flatland* briefs the audience before sending them as spies to his lightless homeland: a two-dimensional world of sorts.

Flatland is experienced only through sound, movement and touch. Robbed of sight, the only way to navigate the environment is by placing your trust in a hand-held cube created by Ad Spiers, a postdoctoral associate at GRAB Lab, Yale University's centre for studies in robot manipulation and biomechanics. Its top half jutting and swivelling, the cube leads you through a tightening spiral corridor, or past a

"Robbed of sight, the only way you can navigate is by placing your trust in a hand-held cube"

jutting clutch of pipes and tubes, and into an immersive, often eerie story.

GRAB Lab's unobtrusive cube suggests how a new generation of haptic devices might guide both visually impaired and sighted people around museums and heritage sites, leaving their senses open to their surroundings.

But the play's the thing, and genuinely new forms of theatre don't appear often. Even at this experimental stage, *Flatland* announces the arrival of a compelling (if slightly oxymoronic-sounding) new art: sightless theatre. ■

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The Association of Universities for Research in Astronomy (AURA) seeks a new Director for the Space Telescope Science Institute (STScI). STScI is located at several sites on or around the campus of the Johns Hopkins University in Baltimore, Maryland. STScI is operated by AURA under contract with NASA to conduct the science program of the Hubble Space Telescope (HST) and to develop the Science and Mission Operations Center for the James Webb Space Telescope (JWST). STScI also operates the Barbara A. Mikulski Archive for Space Telescopes (MAST) for NASA. In the case of HST, the Institute solicits and selects observing proposals, supports observers, plans and carries out the scientific observations, calibrates and archives the data, and distributes grant funding. For JWST, the Institute is currently designing and building the ground system, as well as the systems required to align and maintain the telescope and instruments, in preparation for taking responsibility for both mission and science operations in 2019. STScI is, and will be, responsible for the Education and Outreach activities of both of these very prominent missions.

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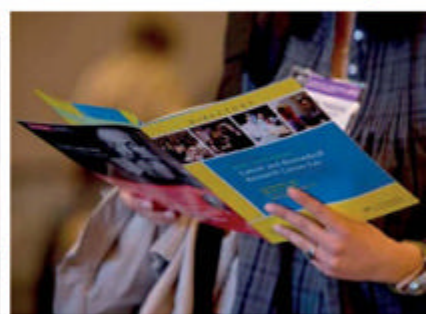
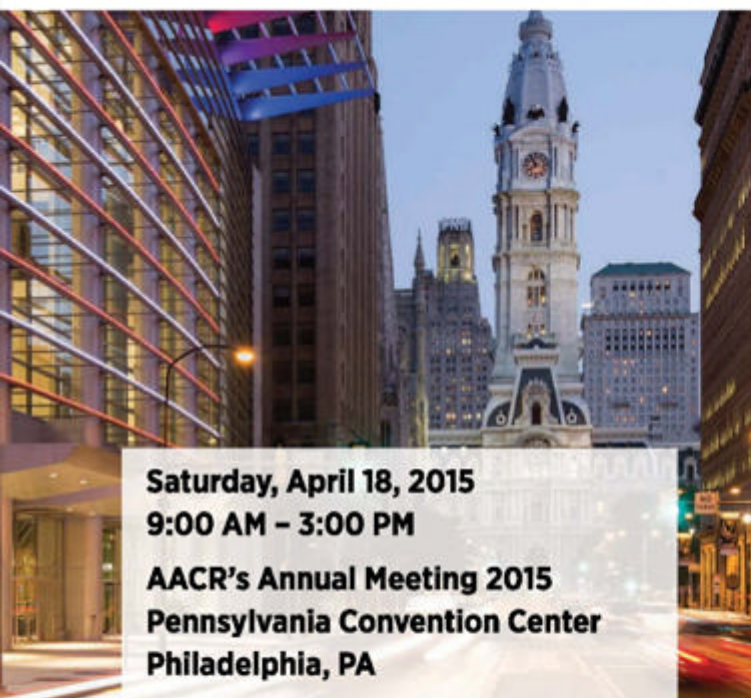
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Garth Illingworth, Chair
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Elements of a crisis

From Oliver Sacks

I look forward to receiving each issue of *New Scientist*, but I was especially impressed by the articles, the tables and the tremendous amount of research that went into Andy Ridgway's report on the state of the world's supply of critical elements (14 February, p 35).

You ran an earlier article on this subject in 2007, and were kind enough then to publish a letter from me (23 June 2007, p 23) in which I mentioned some historical examples, such as the near-sinking into incandescent bulb filaments of the world's osmium production (only about 2 kilograms per year in 1900), and how a crisis was averted by switching to tantalum and then tungsten filaments.

Now, as you bring out, we are ransacking the entire periodic table for rare-earth phosphors etc, and there are fewer and fewer substitutes for these. Ridgway's article deserves the widest publicity, for while we talk a lot about other depletions threatened by our ever more technology-hungry world, neither the public nor our lawmakers know enough about the great rare element crisis which now faces us. *New York City, US*

Labelling the exits

From Jordan Posamentier

In writing about the rise of right-to-die legislation in the US, Clare Wilson uses the term "assisted suicide" (28 February, p 13).

Philosophically, it might at first blush be tempting to think of a person who self-ingests a prescription of life-ending medication as committing suicide, but it is no more a suicide than if a person jumps from a high floor of a burning skyscraper rather than be consumed by flames. The question for these people isn't whether they will die,

but whether they can choose the conditions of their own death.

The states that protect this process distinguish it legally from assisted suicide, which may still be illegal. In the case of terminally ill patients who are able to end their life, the coroner may list the terminal illness, not suicide, as the cause of death. And insurance companies do not consider these deaths as suicides when deciding whether to pay out benefits under an insurance policy.

Psychologically and medically, calling the process suicide hurts patients and their families and does not reflect best medical practice. Major organisations in the fields of psychology and medicine support this view.

"Assisted suicide" is thus inaccurate and inappropriate. Better terms include patient-directed dying, physician-assisted dying, or "physician aid in dying". *Seattle, Washington, US*

From Keith Anderson

Let me thank Clare Wilson for the professional and unbiased report of the assisted suicide situation in America. However, I felt some of the comments from Diane Coleman, who opposes the practice, were potentially misleading.

Coleman voices concern that because some people waited longer than six months before taking the life-ending drugs they had procured, the process was being offered to patients who were not terminally ill. But the requirement that these people would die "within six months" is an artefact of the limitations of trying to define "terminally ill".

Coleman also cites that patients may feel "a duty to die rather than a choice to die". This interpretation of burden on family is common among opponents of assisted suicide reform, and assumes an authoritarian world where doctors tell and patients do; where patients have many duties and no choice.

The euthanasia debate is controversial because most modern people have an entirely different, "patients' rights" world view, where patients tell and doctors do. In this world, voluntary euthanasia is just another service they expect any modern healthcare system to be able to provide.

Kingston, Tasmania, Australia

Getting a head start



From Keith Fincher

The possibility of transplanting a head and joining the spinal cord by simply flushing the joint area with polyethylene glycol (PEG) appears simply astounding (28 February, p 10).

Repairing nerve damage after traumatic injury is extremely important for full recovery but often not successful. Presumably, the polymer provides a suitable scaffold and environment to grow and join axons.

In light of the importance of the fatty myelin sheath protecting axons (21 February, p 30), I wonder if another group of compounds, the polyethers, might work better than PEG because they are more hydrophobic.

PEG is completely water soluble. Polypropylene glycol (PPG), a polyether, is insoluble in water but can be made soluble by terminating molecular chains with ionic groups. PEG and PPG can be combined with copolymers that act as dispersing and wetting agents. Many other variations

exist and I wonder if anyone has considered or experimented with these materials for nerve repair.

Drysdale, Victoria, UK

■ The editor replies:

The researchers are looking at PEG with two other chemicals, but it's only one of many hurdles to overcome in this procedure.

Beating migraine

From Bob Ardler

There is indeed a cure for migraine that works for some, especially those warned of onset by the aura (7 March, p 38).

After a few years of migraine agony in my teens, I found a *Reader's Digest* article which advised that as soon as you experience the aura, you should lie down and relax every muscle from toe to head. It worked for me. No more migraines for five years – until I mistook an aura for sun glare and ended up in hospital. I have since remained migraine-free for 55 years.

Many migraine sufferers I have spoken to have dismissed the method without trying it. Others are cured for life. What is the science here?

London, UK

From A. R. Tapp

As a long-standing migraine sufferer, I was very interested in Helen Phillips's article, but she did not mention a cure that works for me and others.

I had been suffering from what she labels a silent migraine. Once a week or so I would experience a blind spot followed by wiggly flashing lines in my vision, which disappeared within an hour, and with no apparent after-effects. My daughter's circle of friends recommended taking magnesium tablets. Since taking them once or twice a week, I have had no further migraines. I hope this idea might help a few others.

St Nicholas at Wade, Kent, UK

■ *The editor notes:*

We advise readers to discuss any migraine treatments with their registered physician.

No to nightingale pie

From Diana Taylor

I was saddened to hear about the plight of migrating songbirds decimated by poaching (14 February, p 48). Are the activists who tackle the poachers also picketing restaurant owners who serve these birds as delicacies? Are they shaming the patrons who eat the little birds?

Such actions might prove more fruitful than going after the hunters. The restaurants are probably located in urban centres and thus easily exposed to the glare of publicity.
Ottawa, Canada



Anodising delay

From Chris Tindall

I read with interest Hal Hodson's article on the use of aluminium as a steel replacement (28 February, p 22). I have been producing control software for metal finishing production lines for over 20 years, and foresee a bottleneck that will hamper the increased use of aluminium.

Steel parts are commonly electropainted to increase corrosion resistance and to provide a key for further finishing. Aluminium parts are anodised for the same purpose. The problem comes in the time

difference between the processes. Electropainting takes 2 to 4 minutes, while anodising takes 20 to 40 minutes. To get the same throughput in parts processed, production lines will have to be much bigger, and that will require major investment.
Southampton, UK

A touch undervalued

From Peter White

In her article on touch, Linda Geddes reported research showing that people who have had a stroke can "recover a lost sense of limb ownership if the arm or leg is stroked on a regular basis" (28 February, p 34).

This led me to think of body integrity identity disorder, a condition in which people feel uncomfortable with or reject one of their own limbs and may wish to have it amputated. I wondered if regular stroking of the limb in question would help these people to accept it as their own?
Cardiff, UK

■ *The editor replies:*

This question came up, but didn't make it into the feature. If we include anorexia as a kind of body dysmorphism, then at least one researcher definitely thinks touch plays an early role in these disorders.

From Valerie Yule

Both as a psychologist and a mother, I have witnessed the importance of touch for babies. Often touch is life-giving for sick children. But at the same time, parents are taught to make babies sleep and play alone; babies are deemed "good" once they have learned this and cease to cry when left on their own.

In the West, babies are put in separate rooms, and taken around in prams that do not let them even see or hear their parent. Yet people do not wonder why babies cry when left alone and stop when picked up. Surely it is because

babies know what they need.
Mount Waverley, Victoria, Australia

Dead zone revisited

From Tim Symonds

Fred Pearce writes that the world's largest conservation fence is being constructed around Mount Kenya (28 February, p 16).

In 1955, I was a 17-year-old Kenya Police Reserve tracker team leader in the Mount Kenya Crown Forest. My patrols entered the forest by crossing "the dead zone", a mile-wide cleared area stretching around Mount Kenya during the Emergency.

This was designed to hamper the ability of Mau Mau groups to obtain food from sympathetic or cowed villagers settled along the slopes of the mountain.

My forest activity was designed to keep the Mau Mau moving, making it impossible for them to obtain sufficient food within the forest itself, and force them to cross the dead zone where they could be spotted and attacked.

The mountain was a through-way for big game, especially elephant and rhino, to cross from feeding grounds on opposite sides of the Crown Forest. Reading Pearce's article, I wonder what effect the immense strip of cleared land must have had on the mountain's wildlife?
Burwash, East Sussex, UK

I, Carbot

From Tony Holkham

The points raised by earlier correspondents about driverless vehicles are salient (28 February, p 54). I can add another: when there are choices to be made, for example if traffic lights fail, sensible drivers usually rely on eye contact. How will that work with a driverless car?

Surely the interactions of the cars with humans will raise the

same problems expected with intelligent robots? I can't help thinking that the proponents of driverless vehicles haven't thought through the implications thoroughly enough, and had better go and think it out again. Isaac Asimov might be a good place to start.
Blaenffos, Pembrokeshire, UK



Name games

From Ralph Reid

Given your *Feedback* discussion of nominative determinism (28 February, p 56) it was nice to see, on the preceding *Letters* pages, Mary Voice speaking out, Paul Coyne discussing financial efficiency, and Jon Wise asking intelligent questions.
Coolamon, New South Wales, Australia

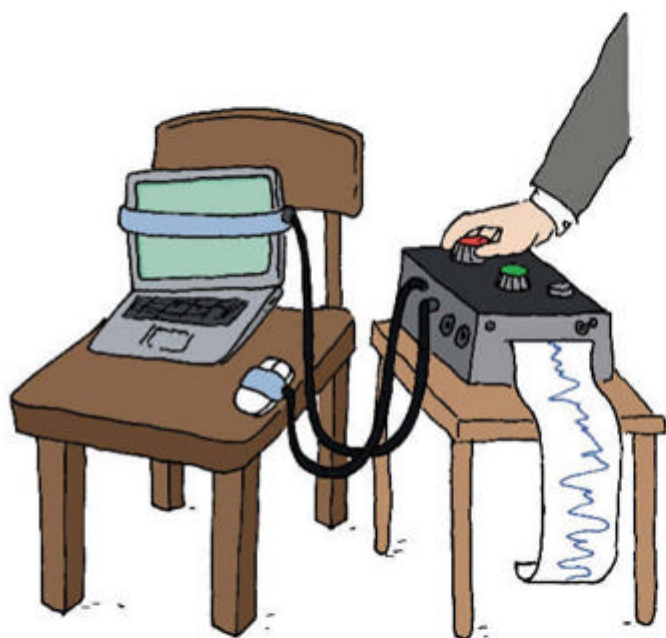
For the record

■ **The Dutch city of Nijmegen may one day be a coastal city - as it was described in our article on climate-proofing Europe (7 March, p 10) - but it is currently about 100 km from the sea.**

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RANKING internet search results according to how well they reflect “facts the web unanimously agrees on” (28 February, p 24)? What could possibly go wrong?

Adrian Ellis wrote to ask about something the web is unanimous on: that glass is really a very thick liquid (14 March, p 54). Well before the ink was dry on his letter, a colleague asked a FWSE (famous web search engine) about this.

It shot back: “Antique windowpanes are thicker at the bottom, because glass has flowed to the bottom over time... Glass is a supercooled liquid. Glass is a liquid that flows very slowly.”

At first glance, the web page it was quoting seems to exemplify a core Feedback hypothesis: that the internet holds many false beliefs, the more fruitloopy of which we catalogue.

However, closer inspection reveals a different flavour. The

above text is from a page (bit.ly/GlassLegend) entitled “Glass: Liquid or Solid – Science vs. an Urban Legend”. It is in fact debunking the ideas quoted. This is a prime example of artificial stupidity. The search ranking system cannot tell the difference between myths and statements that mention them.

PERHAPS we can help refine artificial stupidity. Krista Nelson wrote to ask whether Feedback could compile a list of our suggested fruitloopy indicators: “I think it would be a valuable resource.” As it happens, she did so while the ink was drying on our first draft, in which we consulted the UK’s Advertising Standards Authority about “vibrations”, “homeopathic”, “quantum” and “tachyon” (14 March).

Happy to help. Watch out also for these words and phrases: “as Albert Einstein said”, when he didn’t (11 October 2014); “scalar waves” and

“scalar fields” in contexts involving healing (27 February 2010); “far-infrared” in connection with bracelets, clothing or horse blankets (17 November 2012); “georesonance” in any circumstances that we can currently think of (17 May 2014).

If you spot questions such as “can you change your DNA?” and you’re not reading about radiation protection, run (27 July 2013); contrariwise, shun offers of “radiation shielding” for electronic devices such as mobile phones whose functionality depends on emitting radiation (many references since 6 October 1990).

Equally, beware of purveyors of “negative ions” outside chemistry textbooks (24 September 2011), and of “hydration”, especially if it involves weird water (15 September 2001).

Have we missed anything? And will these references trick an artificial stupidity into citing the above as facts?

MORE artificial puzzlement is provided by Adobe, whose Flash software seemed to have a bad time in early February, with a vulnerability reported every few days. So we went to the “About Flash” page on Adobe’s website to see whether our version was at risk. This page offers a routine that is supposed to tell us what version of Flash we are running. Our Firefox browser refused to run this tool, declaring it obsolete. How did Adobe think it would be a good plan to use Flash to check whether we risk hacking when we run Flash?

SUPERNATURAL puzzlement is supplied, meanwhile, by Mohan Bhagwat, supreme leader of the Hindu-chauvinist organisation Rashtriya Swayamsevak Sangh (RSS). On 8 February he told followers that their goals must be “to ensure one language, one god and one religion”. Feedback has no actual qualifications in theology, but had understood from talking with mathematicians with Hindu backgrounds that a defining characteristic of Hinduism is arguing over whether the number of gods is countably infinite or just very large.

Looking into the matter further,

we discover a tangled discourse about Hindu monotheism. Some dismiss it as a “modernising” acceptance of Judaeo-Christian-Islamic values and preconceptions. Then on 20 February, Bhagwat announced: “we pray different gods”. We’re not sure whether this was an about-face, or of which “we” he was speaking.

Feedback is sticking with alatrism, defined as “not bothering to worship any deities, regardless of how many there may be” (22 July 2006).

FINALLY, we have, naturally, had a slew of further examples of nominative determinism – in which a person’s name appears to have influenced their occupation (28 February). For now, we return to a case that Jim Harris describes as “the ultimate in nominative determinism for a scientist”.

A while ago, we were mildly sceptical about the European Southern Observatory’s list of



science staff in Santiago, Chile (1 October 2011). We harboured a suspicion that “Willem-Jan de Wit may have been humorously involved” in one entry, as may Jeff Wagg. Now, Mike Egan has succeeded where we failed and found an ESO page for the person we doubted. When we remarked on this, a colleague replied “ah, yes, I had a call from them last year...” Step forward, please, Henri Boffin.

You can send stories to Feedback by email at feedback@newscientist.com. Please include your home address. This week’s and past Feedbacks can be seen on our website.

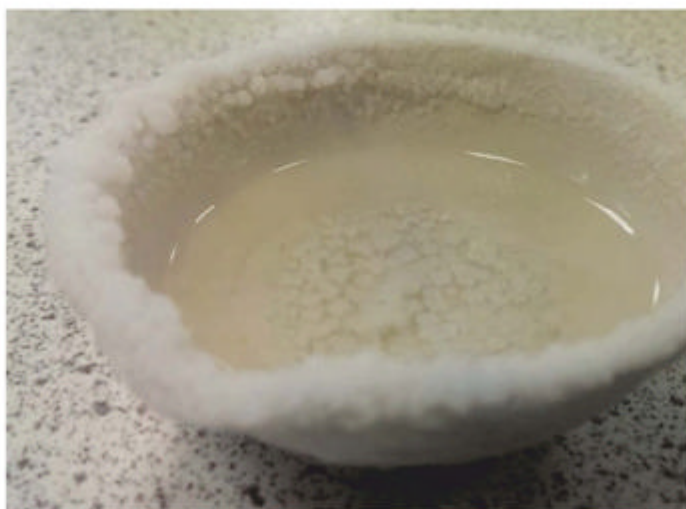
Want to moor a boat on the River Thames at Sonning? Andrew Doble sends evidence that it’s free for 24 hours; £5 per day for the next 48; and “£50 per day for all stays over 48 hours” So on the third day – what?

Furless midriff

My Year 7 class left brine in evaporating dishes next to a sunny window. Several pupils ended up with dishes like the one pictured. We could explain the salt crystals at the bottom of the dish, but why is there no deposit around the middle of the dish when the rim is thickly furred with salt?

■ There is actually a thin layer of salt deposited in the mid-band of the dish. The real question is why a much thicker layer of crystals formed further away from the liquid. This is because of the combined effects of capillary suction and evaporation.

Around the edge of the liquid, surface tension causes the solution to rise up the wall slightly. This layer is thin and has a high surface area to volume ratio, so experiences a high rate of evaporation that causes salt crystals to precipitate around



precipitation accelerates. Eventually, the liquid is sucked so far from the bulk that the rate of evaporation equals the maximum capillary flow rate, at which point most of the salt crystallises out and forms the large deposits you can see.

In some situations with very low evaporation rates, I have seen salt deposits continue to grow over the rim, down the outside of the dish and onto the bench.

*Simon Iveson
Callaghan, New South Wales,
Australia*

■ If some of the evaporation dishes are slightly porous, the dissolved salt could be migrating through the clay. The water evaporates preferentially at the highest point, leaving behind the precipitated salt on the rim. The middle is too dilute

and has too low a concentration of solution to form crystals.

As a potter, I see this when I reclaim clay slop in porous bowls, in which dissolved salts in the clay precipitate at the top lip only. Egyptians used salt migration to make self-glazing pots. Salts would migrate to the outside of the clay, and would then combine with the silica in the clay to form a glaze when firing.

Today, potters add soluble forms of sodium to trap carbon in Shino glazes to achieve a charcoal-grey spotting pattern. The sodium migrates with the water from the glaze to the outside and top of the pot. The sodium compounds melt early in firing and, if there is a lot of soot in the kiln chamber at that temperature, the soot will get trapped in the glaze, appearing as black areas on the finished pot.

*Jennifer Assinck
Newmarket, Ontario, Canada*

This week's questions

FOOTLOOSE

I sometimes notice that one of my shoes is loose, although the other is fine. When I tighten the laces on the loose shoe, the other shoe then feels loose. Is there an explanation for this peculiar effect?

*Andrew Brittain
Sutton, Surrey, UK*

CLOUDING THE ISSUE

Are there any wavelengths at which the sun still casts a shadow when the sky is full of clouds? Could I make a sundial that would work on a cloudy day?

*Stephen Parish
London, UK*

WHORL CLASS

Do our fingerprints change? When I was a child, I was taught that they never would. However, when I provided my biometrics for a visa application, it was pointed out that my fingerprints did not match those that were taken five years earlier. Is this possible, or is it more likely to be an error with the records or software?

*Chisato Kobayashi
North Yorkshire, UK*

SOUND BARRIER

Is sound sensitive to the composition of the atmosphere through which it propagates?

*John O'Hara
Mount Waverley, Victoria,
Australia*

"Crystals make the surface rough and capillary forces suck solution further up the walls"

the edge. These make the surface rougher, enabling capillary forces to suck solution further up the dish's walls. The further it moves from the main reservoir, the more exposed it is to evaporation and the less opportunity there is for the high salt concentration to diffuse back into the bulk.

The solution thus becomes supersaturated more rapidly at the rim, and the process of

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